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North State Street Bridge, Chicago—South Truss Ready to Be Lowered Into Cofferdam, and North Truss on Adjacent Scow (See Article, Page 140)

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Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

The Civil Engineer in Modern War

Taken from an Address Delivered Before the Annual Dinner of the District of Columbia Section, January 27, 1942

By EUGENE REYBOLD, M. AM. SOC. C.E.

MAJOR GENERAL, CORPS OF ENGINEERS, U.S. ARMY; CHIEF OF ENGINEERS, WASHINGTON, D.C.

WE may as well face the fact that, for a long time to come, there will be no "engineering as usual" in this country. The demands of the war effort have taken, and must continue to take, precedence over everything else. All of our resources must be brought to bear against the powerful combination of enemies arrayed against us. There is no royal road to the "total victory" which must be ours.

For Example, Priorities.~These are with us "for the duration." We have the familiar publicized priorities on steel, rubber, and other materials. But there are in fact other priorities—those which are inherent in a total war effort. There is an inherent priority on labor, and another on federal funds. And there is also a priority on engineering talent. The engineering talent of America is one of our greatest resources—and have we not emphasized the fact that all of our resources are in this struggle up to the hilt?

The phrase "engineering talent of America" covers a multitude of items. To discuss the role of the engineer in our war effort would be to discuss every step, every aspect, and every phase of that effort. The gun which the soldier shoots, the grenade he throws, the mine he lays, the "jeep" he rides in, the water he drinks, and the buildings in which he is quartered—all of these represent the fruits of the works of engineers.

Obviously, I cannot here and now attempt to discuss every aspect of the war effort. I must impose on myself some limitations. Let the chief one be this: let me talk of a single component of the engineering profession—the civil engineer; and of a single aspect of the war effort—emergency construction, in the zone of the interior.

A Huge Task.~The organization which I represent—the Corps of Engineers of the Army—has always had heavy responsibilities, both in peacetime and in wartime construction. Recently, our wartime responsibilities were greatly increased by the transfer to the Corps of Engineers of the work formerly accomplished by the "Constructing Quartermaster." Our present responsibilities encompass all theaters of operation, and of course the home front (or zone of the interior). In our present program are such items as cantonments, air bases, airplane assembly plants, ordnance factories, supply depots, railroads, and harbor facilities.

The job we face is a big one. To describe it, I must borrow a word from Hollywood: the job is colossal. This colossal job is a challenge to the Corps of Engineers—and it is a challenge to the civil engineers of America.

How Meet the Challenge?~Those are proud words. Now let us get down to cases. Let us see how the combined talents of the civil engineers of America—both in and out of the federal service—are contributing to the war effort.

First, there are two points about my own organization which I would like to emphasize. One has to do with our method of functioning. We function, and for many years have functioned, through our "Engineer Divisions," and "Engineer Districts." These Divisions and Districts cover the entire country—and now, certain theaters of operation as well. The system is essentially one of decentralization—"giving a good man a job, giving him the means and authority, and letting him go to it." This is the very negation of bureaucracy and red tape. The system has proved itself in normal times and now it is standing the acid test of war.

Civil Engineers Are the Key Men.~Our organization is sound. But the functioning of any organization depends on men. This brings me to my second point of emphasis. The backbone of the construction branch of the Corps of Engineers is its body of civil engineers. Most of these engineers work under the civil service system. Many of them are leaders in the engineering profession. Many of them are members—yes, officers—of this Society.

In normal peacetime work, our policy has been to supplement the talents of our own engineers by the talents of private practicing engineers. We have expressed this policy chiefly through the practice of employing consultants. Many of the engineers famous in this society and prominent in its proceedings have worked and are working with the Army Engineers. Many are the problems which we have solved jointly with these practicing engineers during the past decade—a decade of

great public works, such as Fort Peck, Bonneville, Muskingum Valley, and the Lower Mississippi Valley. These and many other classics of engineering stand as monuments to America's civil engineers, federal and private.

Transferring Some Burdens.~So much for background. Now let us return to the load thrown on our shoulders by the program—the colossal program—of war construction. When that program first took shape, one salient fact became evident: the program was beyond the existing capacity of any governmental construction agency; but it was not beyond the capacity of the American engineering profession. There arose, then, the real question: whether to accomplish the work by a many-fold expansion of existing federal engineering facilities (drawing on the private engineering profession for the additional engineers needed); or, to find a way of transferring a proportionate share of the load to the shoulders of the private practicing engineers of the country without unduly disturbing the existing order of things.

We have chosen the latter course. We have done just what I have intimated—transferred to the private engineering profession a large share of the war construction load.

We have effected the transfer of the load of war construction to the private practicing engineers by means of special forms of contracts. Rather than get into a discussion of contractual matters, I shall simply go to the records.

A Concrete Case.~Some months ago, there arose a need for a number of "Air Depots" to be located over the country. Now, an air depot is a very considerable item. Its cost is of the order of 25 million dollars. It is a small city within itself, and includes supply and maintenance facilities of many types. It is an essential link in the functioning of an effective air force. It is a place where "they haul the wreckage in on a wheelbarrow at one end, and fly the rebuilt job out at the other end."

When the need for air depots crystallized, there were in existence a few "type plans" for general supply and repair installations. At the time these plans had been drawn, no one had ever even heard of an air depot. A complete and comprehensive job of design was called for. It was a job which scarcely could have been undertaken by any existing federal agency without radical expansion of engineering facilities.

Our actions in this case were typical: We contacted a number of private engineer firms, and placed the problem of the air depot before them. After brief negotiation, one of these firms was chosen and an "architect-engineer" contract was negotiated—on a cost-plus-fixed-fee basis. This firm proceeded just as though it were doing a rush job for, say, the U.S. Steel Corporation. The private engineering firm redrew the "type plans," incorporating in them all the special items specified by the Air Corps. When the firm had completed its work, we had available new "type plans" for the air depots which were modern and comprehensive.

Similarly with Construction.~So much for the design aspects of our work. I might remark in passing that the same principle—the principle of sharing our burdens with the country's engineering profession—has been applied to the actual construction of certain projects. There was, for example, the case of an aircraft assembly plant to be erected in the Middle West. This project is now progressing under the "architect-engineer-manager" type of contract. By this contract, the firm of private engineers draws the plans and specifications, prepares the advertisements for construction contracts, draws the work schedule, and inspects and supervises the actual construction.

The picture I have drawn is one of a free and progressive engineering profession whose activities are integrated into the national war effort. Note that I say "integrated"—not "regimented." Between the two words, or between the two implications, are all the differences existing between our way of life and that of our enemies. The once-proud engineering profession of Germany is today regimented. There is a Nazi outfit called the "Organization Todt," which owns the German engineering profession, as well as the German construction industry and even the German equivalent of CCC, lock, stock, and barrel. Under the Nazi system, an air base, for example, would be built by simply assigning to the job certain engineers and certain ex-contractors. No one, from the top engineer down to the grimiest laborer, would have any choice in the matter. The Organization Todt tells them; it doesn't ask them.

As for us, we will continue to handle our war construction in the American way. And one of the prime reasons why ultimate victory will be ours is that our engineering profession is stronger, more progressive, more vigorous than that of our enemies.

Civil Engineers as Actual Combatants.~And now, for one final time, let me uncover that favorite phrase: "This is an engineers' war." It is that, all right. But, someone may observe, it is still a soldier's war when it comes to the actual fighting. Engineers, it may be claimed, do their admittedly invaluable work back in the rear, in the "Zone of the Interior," far from the smell of powder.

Well, I have an answer to that. I have it in the records of the Engineer units of our new Army. I speak now of our combat units: divisional battalions, ponton companies, water supply battalions, and all the rest. These units are officered to a large extent by civil engineers—young civil engineers who are reserve officers, graduates of R.O.T.C. units. Precise up-to-date figures may no longer be given, but a few months ago my predecessor, General Schley, pointed to a typical engineer battalion in which three-fourths of the officers were from the "Engineer Reserve." That will give you an idea as to the absolutely vital role being played by the younger members of our profession in the actual combat phases of military engineering.

We Engineers Have Key Role.~Today, the armed forces of America are active on many fronts. Those armed forces are growing in strength from day to day. America is aroused and awake. Blood, tears, and sweat may come, but this war for civilization will end in total victory. To the attaining of this total victory, all the professions, all the creeds, all the people of America will have contributed.

The victory will come as a result of the greatest expression of national unity in history. When the final balance is cast, we shall find that—like all other elements of the nation—our profession of civil engineering will have played its part, ably, loyally, and patriotically.

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Aggregate Production for Friant Dam

Giant Structure Will Contain Over Two Million Cubic Yards of Concrete

By C. T. Douglass

Engineer, U.S. Bureau of Reclamation, Friant, Calif.

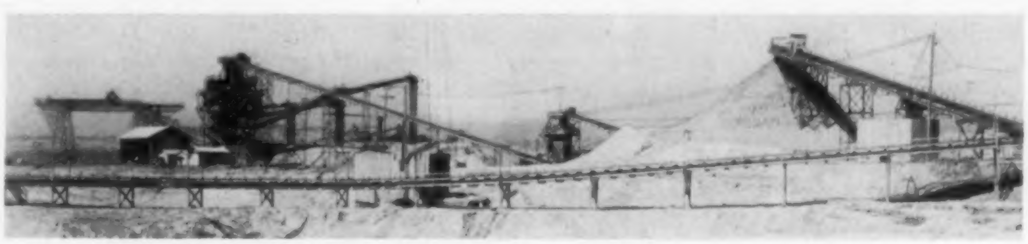
Before actual construction can start on a concrete dam, many important operations must be completed. An organization must be assembled and trained; roads and camps must be built; foundation prepared; concrete mixing and placing plant designed and built; and aggregate produced, processed, and transported. For a dam as large as Friant, these preliminary operations were of staggering proportions. In the case of aggregate production, the plant was capable of supplying more than 9,000 cu yd of concrete every twenty-four hours, or 1 cu yd every nine and a half seconds. This paper is the second in the series on Friant Dam. The first, by Mr. Williams, in the February issue, described the general features.

Among the major features of the Friant Dam construction plant was the aggregate processing unit (Fig. 1) located at the deposit three miles downstream from the dam on the San Joaquin River, north of Fresno, Calif. It was built and operated by the Griffith Company and the Bent Company of Los Angeles, contractor for Friant Dam, which is a part of the vast Central Valley Project being constructed by the Bureau of Reclamation.

The deposit, which is of fluvial origin, contains several types of gravel, including such igneous varieties as andesite, syenite, and basalt, and also sedimentary and metamorphic types, among which quartzite and other siliceous rocks are abundant. The coarser fractions of the sand are similar to the gravel, but the fines contain an appreciable quantity of weathered feldspathic minerals. Mica is present in the sand to the extent of about 4% by volume, and appears to be fairly well distributed through all sizes. In general, the deposit is very clean and well graded, with only about 2% of gravel retained on the 6-in. square screen.

Actual work by the contractor at the gravel deposit was commenced on November 27, 1939. Construction of the processing plant, which had a capacity of 1,000 tons per hour, was begun in December and was completed the following June. Carryalls were used for excavating the gravel down to the water table. Below this elevation, a dragline moved the material into piles for drainage, after which it was handled in the usual manner. Two 36-in. belt conveyors extended into the deposit from a common junction hopper. A receiving hopper was located at the pit end of each conveyor. These hoppers, into which the carryalls discharged their gravel, were covered by a heavy steel grating and were partly below the water table. A steel conduit 7 ft in diameter enclosed the tail end of the conveyor between the timber cribbing of the hopper and the gravel surface. From the junction hopper where the two belts came together, a 42-in. belt led to a raw storage pile having a live storage capacity of 3,500 tons. Gravel from this pile was carried on a 36-in. belt to a 5 by 10-ft vibratory scalping screen, which removed all rocks larger than 8 in. and by-passed them to a No. 5 gyratory crusher.

All material passing the 8-in. scalping screen, together with the crusher product, was carried on another 36-in. conveyor to a 50-ton surge hopper located on top of the 90-ft-high screening tower. The purpose of this surge hopper was to provide for any fluctuation in plant feed or operation, and to make space available to unload the belt in case of plant interruption. On the floor immediately below the surge hopper were three double-deck, 4 by 12-ft, heavy-duty vibratory screens. The top screen of each had 3-in. square openings, and the lower deck had $1^1/_2$-in. openings. Cobbles (3 to 8 in.) were removed on the top deck, and the $1^1/_2$ to 3-in. sizes were removed on the lower deck. Material passing these screens dropped on to six triple-deck screens immediately below. Of these, four were fitted with openings of $^3/_4$, $^1/_4$, and $^3/_{16}$ in., and the other two had a lower deck of No. 14 screen and a middle deck of No. 4, or $^3/_{16}$-in. screen. The purpose of the No. 14 and No. 4 screens was to remove a portion of the sand for sand-blasting in concrete



General View of Aggregate Plant
Raw Storage Is on Right, Crusher and Scalping Screen Next, and Sand Shuttle Conveyor on Extreme Left

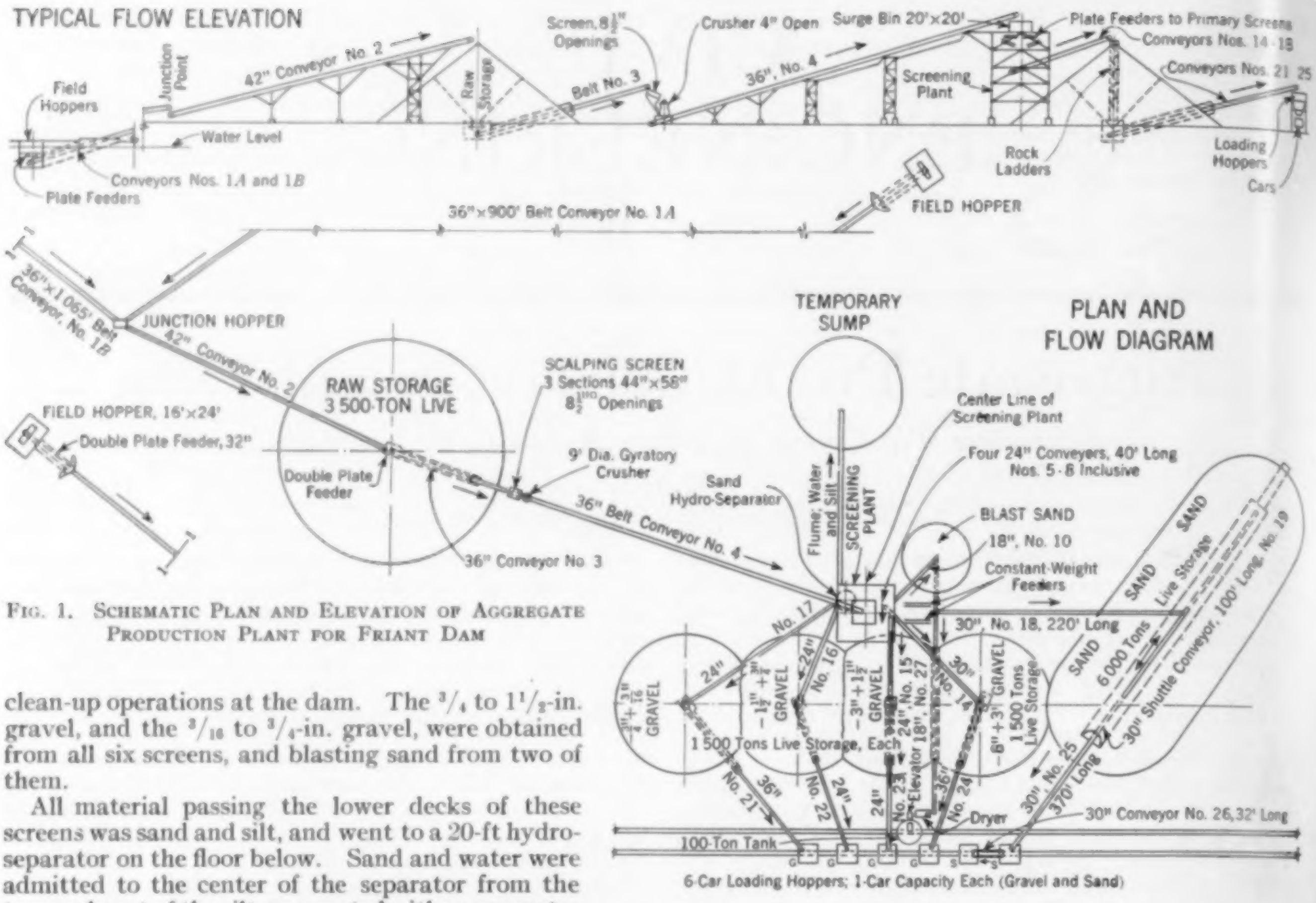


FIG. 1. SCHEMATIC PLAN AND ELEVATION OF AGGREGATE PRODUCTION PLANT FOR FRIANT DAM

clean-up operations at the dam. The $^3/_4$ to $1^1/_2$-in. gravel, and the $^3/_{16}$ to $^3/_4$-in. gravel, were obtained from all six screens, and blasting sand from two of them.

All material passing the lower decks of these screens was sand and silt, and went to a 20-ft hydro-separator on the floor below. Sand and water were admitted to the center of the separator from the top, and part of the silt was wasted with excess water over the periphery. A rake, rotating at 4 rpm, scraped the sand to an outlet in the bottom, from which it went to a bank of four 60-in. by 25-ft screw classifiers. The grading of the sand was varied by changing the speed of the screw or the depth and velocity of the water.

The effluent from the hydro-separator was split and sent to the first two classifiers, which removed the coarse sand. The two following screws were for the finer portion, taking the overflow from the weirs of the first two classifiers. The overflow from the two secondary classifiers consisted mainly of silt in suspension, and was wasted. The two fractions of sand, consisting of coarse from the primaries and fine from the secondaries, were recombined to a fineness modulus of approximately 2.75 by means of adjustable chutes through which the products were fed to the 24-in. conveyor and then transported to the finished storage pile of 6,000 tons.

At the stock pile, a reversible traveling shuttle conveyor permitted equal distribution of the wet sand over the entire storage, thereby making possible a uniform moisture content in the sand loaded out to the concrete mixing plant. The various sizes of coarse aggregate were delivered by means of belts to their respective stock piles. The piles had a capacity of 1,500 tons each, except the No. 4 to $^3/_4$-in. size, which had a capacity of 3,000 tons. Each pile was furnished with a rock ladder to reduce breakage and segregation.

CONVEYORS OPERATE IN WOODEN TUNNELS

Material was reclaimed from the piles by conveyors operating through laminated wood tunnels and extending to the loading-out hoppers of 50-ton capacity. There was one hopper for each size of gravel, and two for sand. These hoppers were spaced along a railroad spur so that each was over a 50-ton bottom-dump car of a 6-car train. All cars of the train could be loaded simultaneously in about 25 seconds. The train consisted of dump cars with a 45-ton diesel-electric locomotive at each end. A three-mile railroad, extending from the aggregate plant to the track hoppers at the dam site, was built and maintained by the contractor. The track hoppers were arranged so that all cars of the train could be dumped simultaneously, the dumping controls being located in the cab of the head-end locomotive. When necessary, the cars could be loaded and dumped individually, so that it was possible to haul other than the usual train load.

The blasting sand coming off the two secondary screens was carried on an 18-in. belt to a stock pile, where it was permitted to drain; then it went through an oil-heated drier to a loading-out hopper. Blasting sand was loaded into dump trucks for transportation to the dam.

Water for gravel-plant operation was pumped a quarter of a mile from the San Joaquin River. Three pumps supplied 4,000 gal per min through a 16-in. line. All the screens, with the exception of the scalping screen, were equipped with sprays operating under about 70 lb of pressure. A total of 1,300 hp, for motor operation, was obtained from a commercial line serving the area.

The sand contained a small amount of gold, and under the provisions of a supplemental contract, the contractor was permitted to recover it, the net profits to be divided equally between the Government and the contractor. Tests were made of several methods of recovery, and it was finally determined that screen-lined chutes were the most efficient. Consequently all sand, after leaving the screens, was passed through chutes 26 ft long by 2 ft wide before going to the hydro-separator. These chutes were lined on the bottom with burlap mat, as well as with screens of 4, 8, and 16-mesh, which acted to trap the concentrates.

Material Not Usable Was Stripped Off Top of Aggregate Deposit with Carryall Scrapers and Tractors

Pumicite Deposit Was in Horizontal Layers from Top to Bottom

Laminated-Wood Tunnel for Loading-Out Belt at Aggregate Plant

Hydro-Separator Directly Above Bank of Four Screw Classifiers

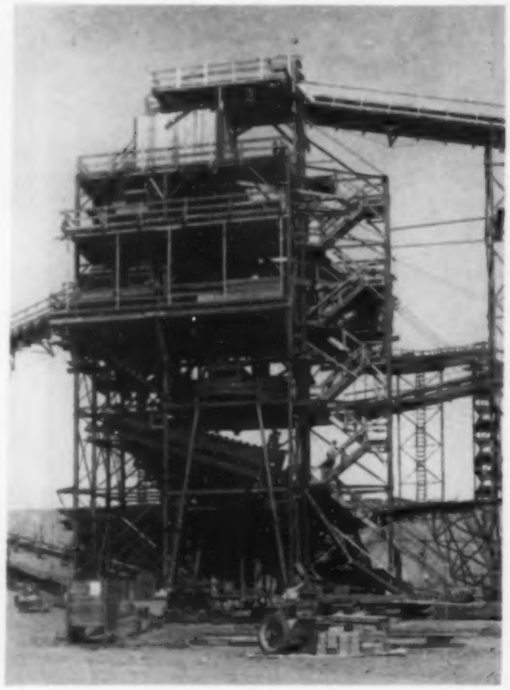
Aggregate-Plant Field Hoppers Being Placed Below Ground-Water Level

Field Hopper Allowed Material to Be Dumped Through a Grizzly Onto Conveyor Belt

From Aggregate Plant to Mixing Plant by Standard-Gage Railroad

When a "clean-up" was made, the concentrates were flushed first into a 24-in. jig, and then through an amalgamating barrel, which trapped the free gold on mercury-coated blades. The gold was reclaimed by scraping the amalgum off the blades and retorting it at a temperature of approximately 2,000 F. The mercury was driven off as vapor, leaving the gold about 90% pure. The gold was shipped to the U.S. Mint in San Francisco. Up to December 1, 1941, the yield amounted to $186,000 or about five cents per ton of pit-run gravel.

Handling and storage facilities for cement were provided and operated by the contractor, and their cost was included in the unit bid price for placing concrete. Cement used at the central mixing plant was delivered by the Government in bulk in box cars provided with removable timber bulkheads, which confined the cement to the ends of the car and left open floor space at the doors for the unloading machine to enter. Cars were loaded to approximately 300 bbl each.



AGGREGATE SCREENING TOWER DURING CONSTRUCTION, WITH ROCK LADDER IN RIGHT BACKGROUND

CEMENT PUMPING AND STORAGE

One 150-hp unloading pump, under normal operation, with one operator and four laborers, unloaded 12 cars per shift. The guaranteed rating of this machine was 340-bbl per hour, and the actual performance averaged between 400 and 450 bbl. A 125-hp machine was provided for emergencies and repair periods, but was rarely used. The cement unloader discharged into an 8-in. pipe line that branched at the top of the silos and permitted the selection of the silo to be filled.

Four steel storage silos, each of 5,900-bbl capacity, were provided. The conical bottom of each sloped 53° from the horizontal to decrease dead storage. The rate of release from the silos was controlled by vane feeders, belt driven by electric motors through variable-speed reducers. The vane feeders discharged into a conveyor screw which fed the cement to a transport pump. Signal lights adjacent to the unloading bay indicated when the silos were full. The telltale installed at the silo "full level" consisted of a rotating paddle that stopped when covered with cement. Use of air jets to start the cement moving out of the silo cones was initiated at the beginning of the job, but was discontinued when satisfactory dewatering of the air was found impracticable.

The original cement contract for Friant Dam provided 1,650,000 bbl of low-heat cement from three companies. The three brands of cement were stored separately in the silos and blended into the conveyor screw to attain uniformity of physical, chemical, and color characteristics. Two supplemental contracts furnished modified cement, which was blended with the low-heat cement.

Cement was pumped from the storage silos to the mixing plant silo through an 8-in. pipe line approximately 1,000 ft in length. The pump was rated at 340 bbl per hour, and actual performance averaged well above that amount.

Dust collectors were installed on the silo top and at the mixing plant. These consisted of a series of tubular wool bags enclosed in a circular tank. A centrifugal blower discharged air from the tank for 1 minute 50 seconds and a large shaker operated for 10 seconds to clean the bags, thus completing the cycle. Cement dust was reclaimed from approximately 250 cu ft of air per minute.

The desire to secure the greatest possible reduction of heat and of accompanying volume change was the primary factor prompting the use of pumicite in Friant Dam. The addition of pumicite also overcame certain objectionable characteristics of lean concrete mixes, such as poor workability, tendency toward segregation, and strength deficiency.

With the exception of the 6-ft layer of concrete on the surface of the spillway section, all the mass concrete contained approximately 20% pumicite, by weight of the cement, and 0.8 bbl of cement per cu yd. This decrease in cement content made an appreciable saving in the cost of the concrete, but the principal benefit realized was that of decreased heat liberation during hydration. Thus there was less heat to be removed by the cooling water circulated through the structure, and the maximum concrete temperature attained after placement was lower. The mass concrete containing pumicite showed a lower strength at early ages than that with no pumicite and containing 1 bbl of cement per cu yd, but after 90 days the difference in strength between the two was less.

The pumicite came from a selected deposit three miles from the dam, on land acquired by the Government as part of the reservoir right of way. It contained three distinct types of material, ranging from exceptionally fine pumicite to pebble pumice of 6-in. diameter, bedded in definite horizontal layers. Two of the layers, one just below the overburden and the other just above bedrock, were used in the concrete. The intervening layers contained sandy material and pebble pumice.

The contract for the purchase of the deposit included a provision whereby the Government agreed to haul 100,000 cu yd of the pebble pumice and store it above the reservoir water line. The excavation and stock piling of this material progressed as the top layer of fine pumicite was removed. The sandy material was wasted. The lower layer of fine pumicite was partially exposed after 1¼-million cu yd of concrete had been produced.

The Bureau of Reclamation imposed a fineness specification which required that 95% of the fine pumicite must pass the 325-mesh screen. Little difficulty was experienced in meeting this requirement. The only processing necessary to prepare the fine pumicite for use in the concrete was to pass it through corrugated rollers set at ¾-in. openings to break up the large lumps. One pair of rollers was located between the truck dump hopper and the belt leading to silo storage.

All testing and inspection connected with aggregate processing and with concrete production up to the point where the concrete left the mixing plant, was supervised by the writer under the direction of R. B. Williams, M. Am. Soc. C.E., construction engineer, Friant Division of the Central Valley Project.

Research for Flood Control Data

Many Neglected Sources Will Yield Important Information to the Patient Investigator

By GUSTAV E. LARSON

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IN his haste to secure the hydrologic data necessary for the design of a flood control project, the busy engineer often overlooks the possibility that others may have been over the same ground before. Too late he discovers that much trouble and expense could have been saved if he had had access to the existing records in time. That such existing material is not always easily located, Mr. Larson readily admits, and hence this article. In it he explains what procedures to follow in running down such "buried" information as may exist in newspapers, county records, hearings before Congressional committees, reports of Government departments, court records, and other sources.

THE extent of hydraulic and related data that have already been collected all over the country warrants the engineer faced with the design of a flood-control project in making a systematic search of all possible sources of such information before he institutes extensive field and office studies. Critical, systematic research can make readily available many neglected sources that may not only increase the range of flood records from fifty to a hundred years, but also provide the information necessary for the coordinated planning of multiple-purpose reservoirs.

To outline briefly the variety of some of the neglected sources, to suggest methods of securing orderliness in the search for "buried" material, and to point the way to a more effective coverage of current engineering records not adequately used, is the purpose of this paper. No discussion of common sources of information will be attempted.

In approaching the problem of collecting scattered information outside the office files, a good "take-off" is the preparation of a "flood guide." This is nothing more than a list of the months of unusually high rainfall in each year of record at each rainfall recording station in the basin to be studied. Such a flood guide is compiled from the U.S. Weather Bureau's *Climatic Summary of the United States*.

Newspaper research in the field is the next step. In preparation for this it is well to determine the location of the more important collections of newspapers that will give flood descriptions for each of the months listed in the flood guide. With the aid of N. W. Ayer's *Newspaper Directory*, and Winifred Gregory's *Union List of Newspapers*, all publications from towns so situated that they may be affected by high water can be quickly located and the flood years determined. Such a newspaper guide will aid the record searchers in locating the more complete and accessible files and will eliminate unnecessary travel in the field. As historical societies, universities, and state libraries are often depositories for many newspapers from all over the state, it is desirable to begin research at such places, consulting other sources in addition to newspapers before continuing research in the field.

Not reliable but often useful in directing attention to unusually high floods are histories of counties in the basin under study. Under such index items as dams, mills, rivers, memoirs, storms, floods, and navigation, accounts of two or three floods can usually be secured in each county. It should be noted, however, that indexes of county history are often incomplete.

In library research of this character, the searcher will find that he can save much time, with increased efficiency and coverage, if he secures permission to work in the stacks. The ability to see and handle at first hand all the material in the library on a given subject such as water resources, often results in the discovery of useful data that would otherwise be overlooked—if card indexes alone were relied upon.

Indispensable to effective research among the numerous state publications is the *Monthly Checklist of State Publications*, 1910 to date. Such publications include engineering bulletins, survey reports, annual reports, and miscellaneous publications of the various state bureaus and departments. The *Monthly Checklist* is arranged alphabetically by states and has an annual index. However, states occasionally fail to forward copies of their publications to the Library of Congress, and in such cases the *Checklist* will be incomplete.

In addition to published matter, voluminous and useful as it is, there are other state data of value to investigators. Much information in the form of unpublished technical

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memoranda, field reports, discharge measurements, field notebooks, maps, pollution reports, project reports, correspondence, recreation studies, preliminary development plans, and other material may often be secured on official request to the several state agencies. A useful publication in directing investigators to likely agencies is the *Directory of Federal and State Departments and Agencies*. This is prepared in mimeographed form for each of the 48 states by the Office of Government Reports.

Decisions in the federal and state courts involving navigability, drainage, stream pollution, water allocation, and diversion should not be overlooked where such problems have been of major importance. Reports of cases involving water litigation may often provide flood data and references to useful private engineering reports. Federal and state court *Reports* are usually available at state historical, law, or university libraries. Because of the lack of a uniform system in the printing of *Reports*, it is desirable for investigators to secure the advice of law librarians or local attorneys in their efforts at legal research when it appears that litigation of some importance has taken place.

Various useful compilations of Federal laws relating to nearly all phases of water development have been prepared. These may be secured by writing to the Superintendent of Documents, Washington, D.C.; to Mr. Elmer Lewis, Superintendent of the House of Representatives Document Room; or directly to the publications divisions of the agencies concerned. In addition to these compilations, there are general indexes to state session laws published by the Library of Congress that can be of considerable use to engineers in quickly locating this type of material.

Some of the more useful of such compilations are *Federal Reclamation Laws* (1937, and supplement, 1941); *Laws of the United States Relating to the Improvements of Rivers and Harbors*, August 1, 1790, to January 2, 1939, in three volumes (House Document 379, 76th Congress, is the *General Index* to these volumes); Frances Laurent, *A Compilation of the More Important Congressional Acts, Treaties, Presidential Messages, Judicial Decisions and Official Reports and Documents Having to Do with the Control, Conservation, and Utilization of Water Resources* (1938). For indexes to state laws, see the *State Law Index—An Index and Digest to the Legislation of the States of the United States*, compiled by the Library of Congress.

Importance of U.S. Government Publications Is Often Underestimated

Of most value to the researcher, although often insufficiently used, are the documents and publications of the U.S. Government itself. By consulting the proper catalogs and indexes, all past Federal surveys, reports, statistical data, and hearings relative to any stream may be determined and readily located in one of several state depositories for Federal documents and publications. Depositories of sufficient completeness to be of real value may be found either at the state university or at the state historical library or both.

In the minds of most engineers a certain mystery surrounds Government publications because of their extensiveness and massiveness. Yet they are the most important of all sources of flood control and related data. To bring out of this confusion some semblance of order and usability, the following list of basic catalogs and indexes is presented. No satisfactory research in Government publications can be done without a careful consultation of these catalogs, which afford practically a complete chronological key from 1774 to date.

Elaborate Equipment Is Used to Photograph Newspapers at the National Archives

1. Benjamin Perley Poore, *Descriptive Catalogue of the Government Publications of the United States, September 5, 1774, to March 4, 1881.* This chronological list of documents, both Congressional and departmental, has a subject and author index in the back. Some publications are missing from the catalog but no other guide for this period is available.

2. John Griffith Ames, *Comprehensive Index to the Publications of the United States* 1881–1893, 2 Vol. This index contains both Congressional and departmental publications although weak in the latter. It is arranged alphabetically by subject and title, and has a personal name index at the end of Vol 2.

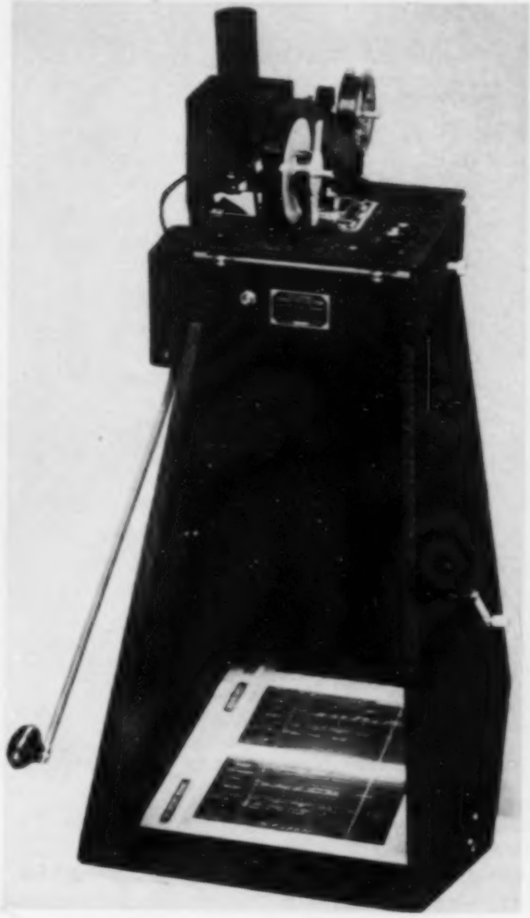
3. *Document Catalog*, 1893 to date. This is issued for every Congress, is very satisfactory, and contains an author and subject index to all Government publications printed during each Congress.

4. *Monthly Catalog of the United States Public Documents,* 1895 to date. This is a classified list of all publications.

5. *Weekly List of Selected United States Government Publications,* 1928 to date.

Prior to 1936 the *Monthly Catalog* included practically no processed publications (multilithed, rexographed, mimeographed). Beginning with the January 1936 issue, such publications, if of sufficient importance, have been included although the listing is not complete. A letter directed to the publications division of the issuing agency is the most reliable procedure for acquiring all the useful processed publications.

Also of importance is the *Checklist of United States Public Documents 1789–1909.* This single volume is practically a shelf list of all the publications in the Superintendent of Document's Library, which is the most complete collection of Government documents in existence. The chief uses of the *Checklist* are to give the serial numbers for Congressional documents before 1909; to find titles, dates, and descriptions of publications of any specific department, bureau, or office; and to get information on the various editions of particular documents, especially early publications, and histories of various agencies in existence in 1909 and before. A knowledge of the *Checklist* and how to use it is fundamental in the study of U.S. Government publications. (For further helpful information, see Anne Morris Boyd, *Government Publications,* 1941, pp. 54–61.)



MECHANICAL "VIEWER" MAKES IT POSSIBLE TO READ THE FILM QUICKLY AND EASILY

Other aids to research, which index many of the important Federal publications and most of the significant articles appearing in current engineering magazines, are the *Agricultural Index, Industrial Arts Index, Engineering Index, Readers Guide to Periodical Literature,* and the *Public Affairs Information Service.*

Increasing attention is being given to multiple-purpose projects. To point the way to the Federal agencies that may be able to provide information on the flood control, power, recreational, and wild-life features of multiple-purpose dams, a list of the agencies concerned is here given:

Executive Office of the President: Water Resources Committee of the National Resources Planning Board.

Department of Agriculture: Office of Land Use Coordination, Office of Experiment Stations, Office of Information, Library, Office of Civilian Conservation Corps Activities, Agricultural Adjustment Administration Office, Bureau of Agricultural Engineering and Chemistry, Bureau of Agricultural Economics, Bureau of Entomology and Plant Quarantine, Forest Service, Bureau of Plant Industry, Soil Conservation Service, Farm Credit Administration, and Water Facilities Board.

Department of Commerce: Division of Publications, U.S. Coast and Geodetic Survey, Weather Bureau, National Hydraulic Laboratory, Inland Waterways Corporation (St. Louis, Mo.), Bureau of the Census, and Service and Information Office.

Department of the Interior: Office of Indian Affairs, Geological Survey, Bureau of Reclamation, National Park Service, Bureau of Mines, Grazing Service, Fish and Wild Life Service, General Land Office, Bonneville Power Administration, and U.S. Board of Geographical Names. Related organizations are the Federal Board of Surveys and Maps, the Migratory Bird Conservation Commission, and the National Power Policy Committee.

War Department: Office of the Chief of Engineers, which includes the Board of Engineers for Rivers and Harbors, Beach Erosion Board, Mississippi River Commission (Vicksburg, Miss.), and the California Debris Commission (San Francisco, Calif.). Also under this department is the Office of the Surgeon General.

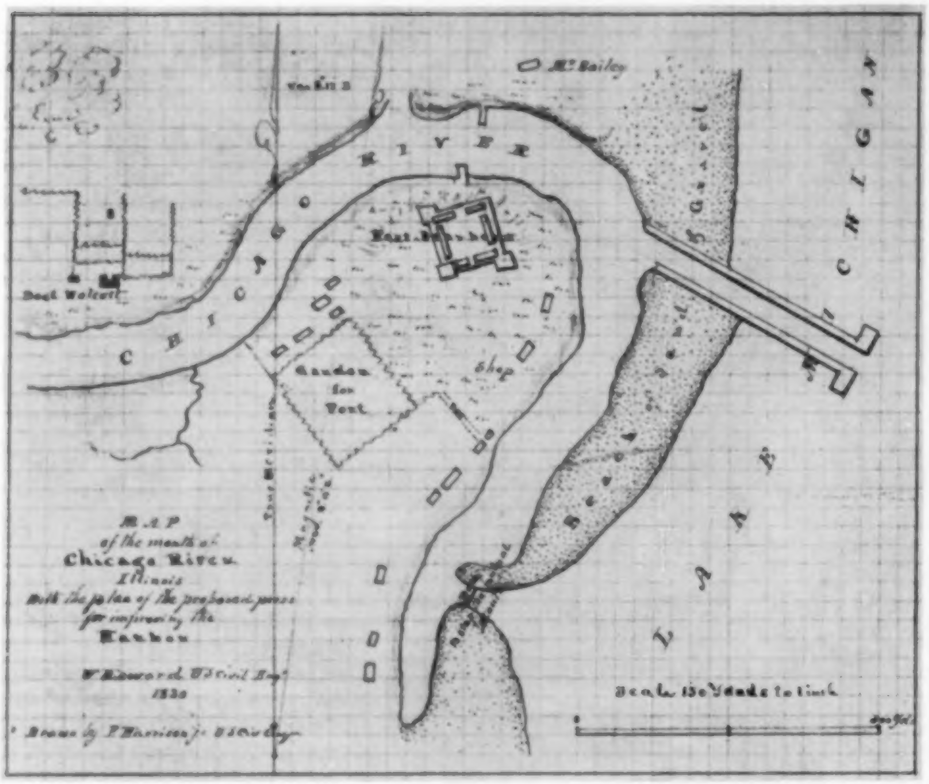
Independent Agencies: Federal Power Commission, Public Health Service, Work Projects Administration, International Boundary Commission (U.S., Alaska, Canada), International Boundary Commission (U.S. and Mexico), International Joint Boundary Commission, National Archives, Reconstruction Finance Corporation, Tennessee Valley Authority, Government Printing Office, and Library of Congress.

CONGRESSIONAL COMMITTEES CONDUCTING HEARINGS

Engineers working on water development projects can find much useful information in the printed *Hearings* of Congressional committees on various proposed projects. These often give specific and general data on the hydrologic and economic features of the drainage basin. As such hearings are listed under the names of the committees (prior to 1910 on pages 1532 to 1652 of the *Checklist,* and later ones in the *Document* and *Monthly* catalogs), the following list of the Congressional committees which to a greater or less degree conduct such hearings will be useful. (Hearings that are conducted by the Departments are usually mimeographed by the field offices.)

House of Representatives: Rivers and Harbors Committee, Committee on Flood Control, Committee on Wild Life, Appropriations Committee, Committee on Agriculture, Committee on Indian Affairs, Committee on Merchant Marine and Fisheries, Committee on Public Lands, and House Document Room (bills, resolutions, acts, documents).

Senate: Commerce Committee (Subcommittee on Rivers and Harbors and Subcommittee on Flood Control), Committee on Agriculture, Committee on Indian Affairs, Committee on Interoceanic Canals, Committee on Irrigation and Reclamation, Committee on Public Lands and Surveys, Committee on Wild Life, and Senate Document Room (bills, resolutions, acts, documents)



ONE OF A SET OF MANUSCRIPT MAPS FROM THE NATIONAL ARCHIVES, RECORDS OF THE SENATE

Other sources of useful engineering data frequently overlooked are township and county drainage records. In beginning a study of drainage districts that may affect or be affected by a flood control project, the engineer should examine the state drainage laws so as to learn the legal nature of the districts and discover the whereabouts of the records. From the orders of the county court, or of the county or town board of supervisors organizing a drainage district, he can quickly get a description of the included lands, acreage, original drainage and flood control improvements, and their original cost. From the annual reports of the drainage district commissioners, he can compile information relative to annual flood damages, cost of repairs, and general silt conditions.

Of most value to engineers, however, are the engineering reports that may have been made in connection with the original improvement or later problems. These usually include maps, profiles, ditch cross-sections, and a discussion of flood and silt problems, which alone are often worth the effort and expense of the research. A foreknowledge of the more important drainage and flood problems of the area and of former surveys will enable the engineer to avoid unnecessary duplication in surveys and to decide what new surveys are most needed.

Another useful compilation that should be mentioned is the preliminary compilation entitled, *Principal Sources of Hydrologic Data*, by W. G. Hoyt, J. M. Davidson, I. H. Sims, Merrill Bernard, G. H. Hathaway and others, which has recently been prepared for the use of various Federal agencies including the recently appointed Subcommittee on Hydrologic Data of the Water Resources Committee of the National Resources Planning Board. This report has not yet been reproduced for general distribution.

After the researcher has located the data, he is faced with the problem of recording it. Two methods of copying such voluminous scattered data have been found successful and are therefore presented for consideration here. Short single items taken from newspapers and miscellaneous sources may be recorded on individual 4 by 6-in. cards and filed in a steel drawer cabinet, according to individual streams, under such subheadings as floods, flood control improvements, levees and drainage, bridges, power and pipe lines, navigation and navigability, transportation, meteorological data, industry, agriculture, pollution, dams, geology, surveys, and gages.

As for the more bulky records—such as reports in the form of books and pamphlets, maps, profiles, cross sections, pictures, technical literature, meteorological daily records, extended records of drainage districts, minutes of meetings, annual reports, engineering reports, court reports, etc.—an efficient and economical means of recording fortunately exists in microfilm reproduction. A standard photo-record camera has been found especially useful for this purpose. Elimination of errors and of the necessity of checking hand-copied data, a reduction in salary and travel expenses, and the small storage space required, are some of the more evident advantages of this method. Data that would ordinarily require weeks to copy can actually be photographed in a day. The camera is of a knockdown type and uses 35-mm positive film in 100-ft lengths. A 100-ft roll will accommodate 800 double-frame, or 1,600 single-frame, exposures.

For reading such records, a standard microfilm reader may be employed. This projects an enlarged image on a ground-glass screen 12 in. square. For editing the film and also for quick reference to a given subject, a home-made viewer can be constructed which consists of a light-proof box inclosing a 15-w light bulb. The film traverses on opening the size of a double frame of film and may be viewed through a seven-power magnifying glass. The light box is mounted on a base which supports two winding wheels. This device may be set up on any desk and is quite useful for the purpose for which it was intended, but it is not satisfactory for continuous use because of the eye strain involved. Satisfactory enlargements can be made on 8 by 10-in. paper.

A closing word of encouragement to investigators may be appropriate. Although there is at present a great lack of hydrologic data and no one source book showing the availability of the data that do exist, it is possible by careful research to considerably extend the range of hydrologic records. To accomplish this an investigator must make maximum use of available services. The importance of diligence, of keeping in mind the many sources of information, of outlining carefully a plan for tapping such information, of continued inquiry, of looking into every drawer, box, file, or book that may contain useful information, cannot be overemphasized. Such effort, systematically made, will insure worth-while results.

Form and Arrangement of Specifications

By Rolf T. Retz, Assoc. M. Am. Soc. C.E.
Associate Specification Engineer, T.V.A., Knoxville, Tenn.

Experience has taught that specifications as well as drawings should be clear, neat, and well arranged. Poorly written specifications lead to high contract prices, unsatisfactory relations between engineer and contractor, and shoddy workmanship in general. This paper by Mr. Retz deals only with specifications for procuring materials or labor or both, and does not cover the subject of standard specifications.

A contract for furnishing materials or labor or both consists of several separate parts, usually divided as follows: (1) the invitation to bid, (2) the conditions of bid, (3) the bid or proposal, (4) the agreement, and (5) the specifications and contract drawings. Each of these parts has a distinct and separate purpose. The engineer, who prepares the specifications, is usually not concerned with the other contract documents; they are as a rule prepared by the purchasing agent with the assistance of the owner's lawyer. However, in order to prepare a well-written specification, the engineer should know the relationship between the specifications and the rest of the contract documents. Much confusion has existed in the past as to the exact subject matter to be contained in each of these parts.

Invitation to Bid is a short announcement to prospective bidders, stating briefly the work to be done and the time within which the bids must be submitted, or the time of bid opening.

Conditions of Bid, sometimes called *Information to Bidders*, contains, as the names implies, the requirements with which the bidder must comply before, and in, submitting his bid. It should therefore not contain any requirements which the bidder must fulfill after he has been awarded the contract. This distinction is important, because it is the key to the reverse requirements in the specifications, which should not contain any reference to the bidder.

The subject matter to be included in the conditions of bid includes such paragraphs as the following: method of evaluating the bid, method of making award, requirements as to bid bond, requirements as to forms to be executed and supporting data to be supplied, and the requirements as to specifications and drawings to be furnished by the bidder. The latter paragraph should be written by the engineer before submitting the specifications to the purchasing agent for assembly of contract documents. The engineer is the person interested in obtaining the technical information contained in the bidder's specifications. Likewise, conditions of the soil, rock, or subsurface, and similar features, should be written by the engineer (or geologist) for insertion in the conditions of bid.

The Bid or *Proposal* gives in schedule form the various items involved in the work, and shows quantities, units, and unit or lump-sum prices for which the bidder proposes to do the work. It also gives the shipping or completion dates promised or guaranteed by the bidder, and includes all the specifications, drawings, and other data or information submitted by the bidder with his bid. It should not contain any requirements to be complied with by the successful bidder after the award, or by the bidder before he submits his bid.

The Agreement contains all articles of agreement between the parties to the contract, that is, all clauses of a strictly contractual, procurement, and legal nature, all of which govern after award of contract.

Sometimes the agreement may be divided into two parts. The first part will then contain the articles which are special for each particular job, such as scope of work, time of completion, the contract sum, progress payments, acceptance and final payment, and definitions. The second part will contain the so-called "general conditions of the contract." The standard documents of the American Institute of Architects provide a very good form where this split has been made. This division, however, is not necessary, and where an organization has a number of widely different contracts, not practicable.

The Specifications contain all the technical, that is, engineering requirements, governing the method and manner of performing the work, and the magnitude and quality of materials or work to be furnished, and include therefore all the requirements over which the engineer will furnish jurisdiction or supervision after award of contract—and none other.

SUBJECT MATTER OF THE SPECIFICATIONS

It is important that this definition of subject matter in the specifications be kept constantly in mind by the specification writer. Otherwise confusion will result, and the bidders or contractor will have difficulty in finding what they are looking for. No one would place unimportant details on a drawing entitled "general plan and layout." Similarly, there is no excuse for placing in the specifications anything that does not concern the engineer and his detailed supervision of the work after award of contract. The engineer's duties are usually, and should always be, defined in the specifications. A common clause reads as follows:

"Work under this specification shall be subject to the approval of the engineer, who shall determine the amount, quality, acceptability, and fitness of the several kinds of work and materials to be furnished hereunder, and who shall decide all questions which may arise as to measurement of quantities and the fulfillment of the requirements of the specification."

This definition clearly limits the engineer's duties and also the subject matter to be contained in the specifications. From this it will be seen that the conditions the bidder must fulfill in submitting his bid do not belong in the specifications, but in the conditions of bid. The word "bidder" should be banished from the specifications, because they deal only with requirements to be met after the award of the contract, that is, those of the contractor. Descriptions of subsurface conditions, for instance, do not belong in the specifications. This is a condition of bid, which the bidder must verify, before he submits his bid, since the engineer usually does not guarantee the correctness of subsurface descriptions. Likewise, any information to bidders concerning such features as weights and freight charges, comparison of bids, and time of delivery desired by the owner, belong in the conditions of bid. And all matters of a legal and non-engineering or purchasing nature belong in the agreement, such as performance bonds, extras, quantities, patents, protests, taxes, liquidated damages, latent de-

fects, failure to meet requirements, right to operate unsatisfactory apparatus, etc. If this clear-cut distinction of the separate functions of the various parts of the contract is maintained, the basis is laid for orderly, systematic thinking and specification writing.

In order to make each part of the contract easily recognizable, a separate numbering system should be used for each. The specifications are divided into "Sections," the agreement into "Articles," and the conditions of bid into "Paragraphs." The numbers should start with Section 1, Article 1, and Paragraph 1, respectively, and should continue in consecutive order.

Specifications should have a short, but adequate, descriptive title, to include either the word "furnishing," or "furnishing and installing," or "construction," or a similar term designating the type of work involved. Examples follow:

SPECIFICATION
No. 356
FOR FURNISHING
STRUCTURAL STEEL STAIRS
FOR
ELLENDALE POWER HOUSE

SPECIFICATION
No. 784
FOR FURNISHING AND INSTALLING
GLAZED WALL TILE
IN
ELLENDALE POWER HOUSE

SPECIFICATION
No. 1184
FOR CONSTRUCTION OF A
CONCRETE-LINED TUNNEL
FOR
ELLENDALE PROJECT

SPECIFICATION
No. 1764
FOR FURNISHING AND ERECTING
THE STEEL SUPERSTRUCTURE
OF
ELLENDALE HIGHWAY BRIDGE

A specification should be divided into two main chapters, called "General Requirements" and "Detailed Requirements." The first should cover the more general features of the specifications, that is, sections which apply to all items of the contract, or to all the Detailed Requirements which follow.

Section 1 of the specifications should always be "Scope of Work." This section should be a brief, but clear and complete statement of what is to be furnished or done under the specification. The opening statement of Section 1 often has a form similar to the following:

"Section 1. *Scope of Work.* The work covered by this specification comprises the furnishing, manufacturing, delivering, and installing of glazed wall tile for Ellendale Power House, including all materials, labor, equipment, tools, scaffolds, and services necessary therefor and incidental thereto, except as hereinafter otherwise provided."

In the case of a procurement specification, where the contract drawings show more material or work than that required under the specification, Section 1 should also list the things which are to be excluded from the contract.

Section 2 should contain a definition of the engineer's duties and responsibility as previously mentioned.

Section 3 should list the contract drawings, that is, all the drawings prepared by the engineer prior to issuance of the invitation to bid.

Section 4 should, if required, state what materials and work will be provided by the owner, and Section 5 should elaborate in more detail on what other materials and work should be provided by the contractor in addition to those outlined in Section 1. In this connection, it should be noted that the word "shall" should always be used in connection with the work required of the contractor and the word "will" in connection with the work to be done by the owner. This will avoid confusion and misunderstandings, if adopted throughout.

Section 6 should, if required, state the requirements as to shop drawings to be furnished by the contractor. This section should outline in detail the procedure, the number of prints of each drawing required for approval by the engineer, the number of days he will require for approval, etc., as necessary to avoid conflict.

Other sections of the General Requirements should cover such subjects as shop inspection, access to places of manufacture and work by inspector, care in preparing shipments, marking of parts for field erection, lines and grades to be given by the engineer, general requirements on materials and workmanship, shipping dimensions, sanitary and safety requirements, cooperation with other contractors, order of work, land for construction purposes, power and lighting, etc., all of which should be of a general nature, and of course confined only to matters over which the engineer exercises supervision.

IMPORTANCE OF THE DETAILED REQUIREMENTS

The meat of the specifications, and in fact of the entire contract, is in the Detailed Requirements, which state the quality of the work to be done and, if necessary, also the methods of doing it. If possible, results should be specified rather than methods. This will depend upon the nature of the work. In some specifications the Detailed Requirements are subdivided into "design," "materials," and "workmanship," or "materials" and "workmanship" only. In other specifications the Detailed Requirements are subdivided into "mechanical," "electrical," and "structural" requirements, and in most construction work the Detailed Requirements are subdivided into a detailed description for each item of the contract. In such cases it is important that each subdivision cover the item completely, that is, what is required, how it is to be done, measured, and paid for.

The how and wherefore of this part of the specifications can only be written by engineers who know their field. The Detailed Requirements must call for the correct design, material, and workmanship, that is, the kind that gives the safest and most efficient service at the lowest price, in conformity with good engineering practice, and in accordance with the best applicable standard specifications of the American Society for Testing Materials, the Federal Specifications Board, U.S. Navy Specifications Board, Society of Automotive Engineers, American Standards Association, or other well-recognized standards.

These requirements must be adequate, but not overfussy or unreasonable. Above all, they must be fair and avoid calling for detailed non-essentials which would eliminate bidders otherwise able to meet the essential requirements. Ambiguities must be avoided, and duplications and repetitions eliminated.

One style and one tense should be used throughout. A telegraphic or broken style will generally cause confusion and should therefore be avoided. This does not mean that the sentences need be long and verbose; on the contrary, short and concise ones are usually the clearest. Tabulations may be used to advantage to shorten the specifications.

Good form and arrangement of specifications are, of course, no guarantee that the specifications themselves are good. But like a good tool in the hands of a skilled artisan, good form is a means to an end. Wherever method and system are used in specification writing, we are likely to reach our objective, which is:

1. To define the work so that any competent contractor can submit an intelligent bid.

2. To establish a guide by which the work can be interpreted with fairness to each party.

3. To provide for adequate competition by stating the essential and minimum requirements only, in accordance with good practice.

The Panama Canal Hydraulics Laboratory

By F. W. Edwards, M. Am. Soc. C.E.

Senior Hydraulic Engineer, The Panama Canal, Balboa Heights, Canal Zone

Established in April 1939 for the purpose of conducting research and model studies for the Third Locks Project, the Panama Canal Hydraulics Laboratory is capable of studying all the problems concerning maintenance and operation of the canal. These problems involve the hydraulics of filling and emptying the locks, surges in Gaillard Cut, maintenance, studies dealing with approach channels, and numerous other detail problems. In this article Mr. Edwards describes the general plan and facilities, types of problems studied, and procedures followed in the laboratory.

The Panama Canal Hydraulics Laboratory is located downstream from the Miraflores Spillway on level ground between the locks area and the spillway channel. The absence of cold weather permitted the adoption of an outdoor installation. Buildings are provided only for housing shop equipment, pumps, and laboratory offices. Shelters are used over the models to permit continuous operation under all weather conditions. The layout (Fig. 1) was planned for the types of problems to be studied. Most of the investigations that have been undertaken were planned in a general way prior to the construction of the laboratory. A compact, flexible plan was adopted which permits ready expansion of facilities when necessary. Other laboratories are located in the same general area—including soils, mechanical and electrical testing, and materials testing.

The hydraulics laboratory offices are on the second floor of the soils laboratory. Shop facilites are in a separate building 35 ft wide by 80 ft long. The shop is equipped with power saws, lathes, shaper, jointer, sander, grinders, drill presses, sheet-metal brake, shears and roller, acetylene welding equipment, and the necessary hand tools. Although the shop is a part of the hydraulics laboratory, it also does work for the other laboratories in the area.

A circulating system supplies water to models and test apparatus. A concrete-lined sump, constructed in the ground without the use of forms, is filled from a 3-in. line connected to the Canal Zone domestic water supply. The sump has 1-on-1 side slopes, 1,764 sq ft of surface area, 11,240 cu ft of volume, and a depth of 10 ft. As the bottom is below the ground-water level, check valves were installed to relieve the uplift pressure when the sump is unwatered. A smaller sump, rectangular in plan with vertical side walls, has been constructed for certain tests requiring relatively small discharges and sensitive adjustments. This sump has a capacity of 560 cu ft and is 3.5 ft deep. A 6-in. pipe equipped with a valve connects the two sumps. Water is returned from the lock models to the main sump through a concrete pipe laid in the ground. A concrete-lined open ditch acts as the return channel from the other models.

Three pumps having capacities of 3,600, 2,200, and 1,200 gal per min, respectively, against a 45-ft head, are installed in the pump house, which is at the side of the

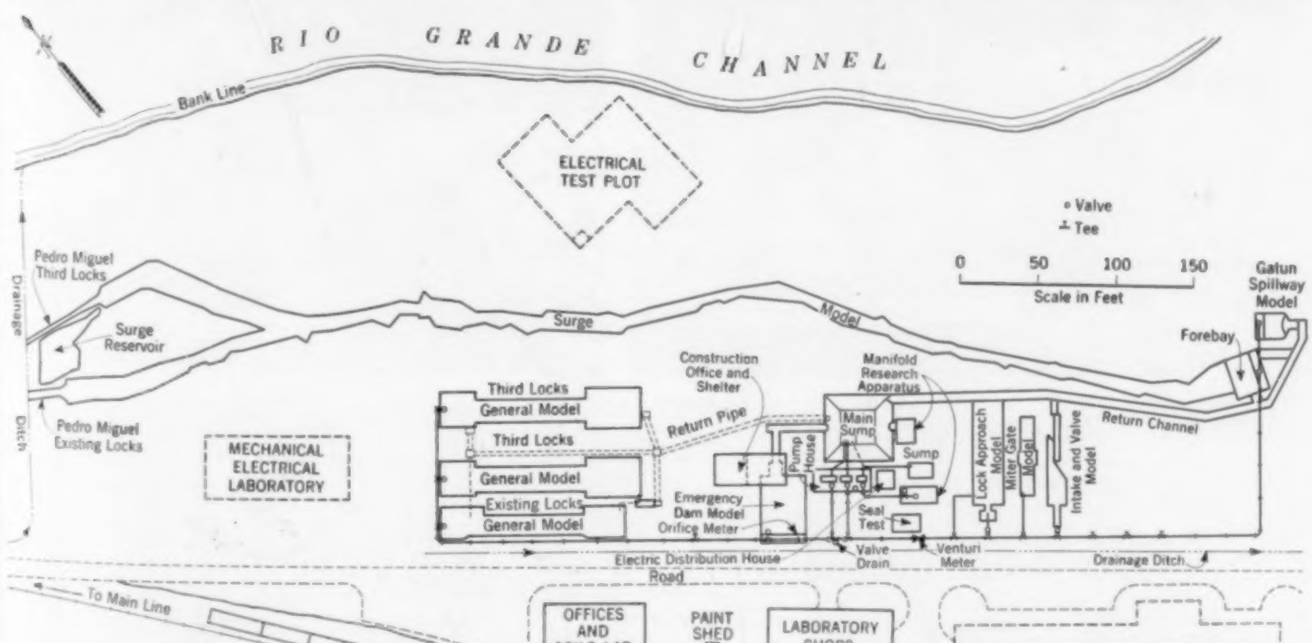
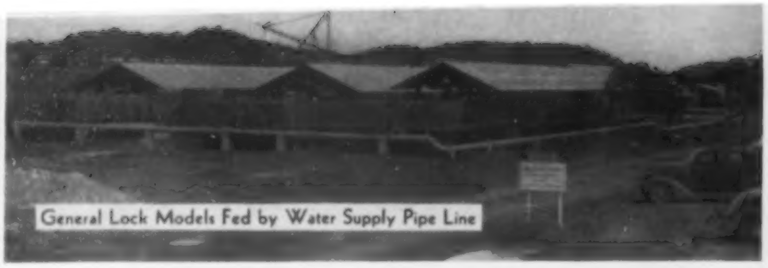
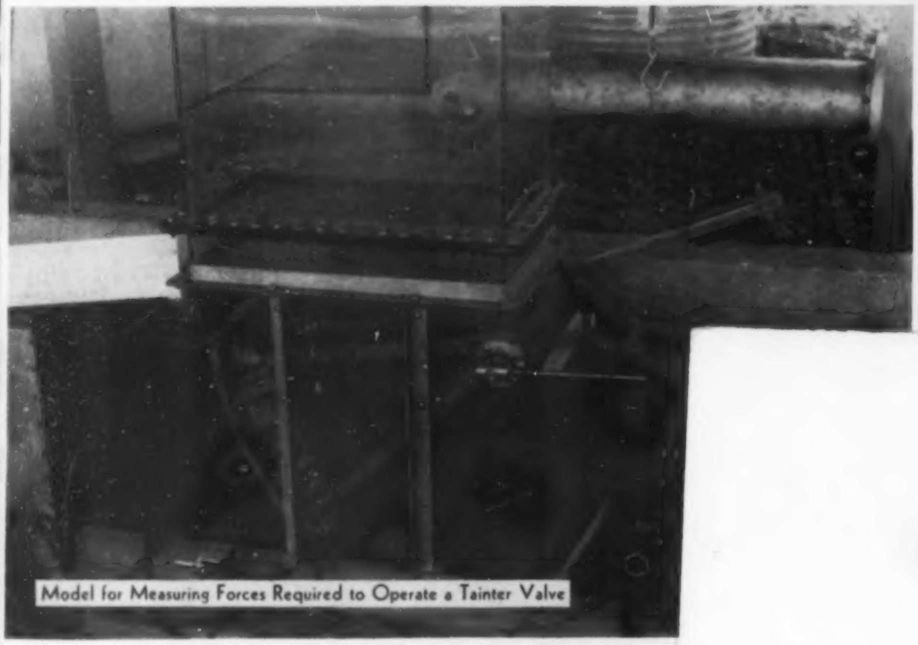
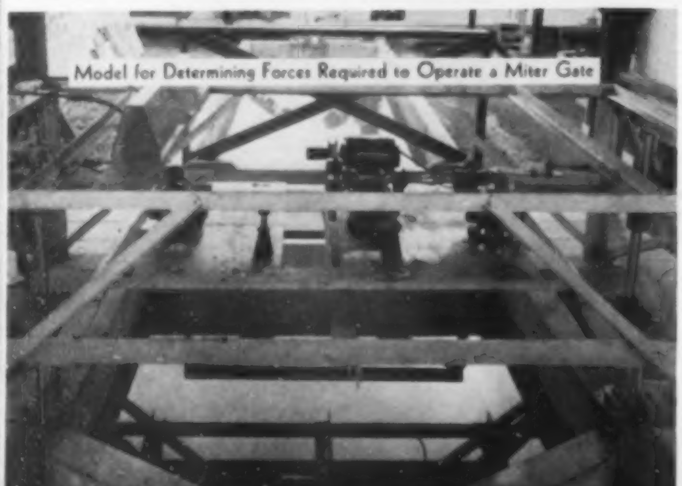


Fig. 1. General Plan of Panama Canal Hydraulics Laboratory


General Lock Models Fed by Water Supply Pipe Line


Model for Measuring Forces Required to Operate a Tainter Valve


Model of Gatun Spillway in


Model for Determining Forces Required to Operate a Miter Gate


Ports of Manifold Test Apparatus, with Main Conduit Removed

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larger sump. A small electrical distribution house stands between the pump house and the smaller sump. The suction line to the smallest pump can be changed readily from one sump to the other. Interconnections are arranged so that the three pumps can be used to supply a single model, or the valves can be operated so that each pump can supply a separate model. The smallest pump can provide an entirely independent system when its suction line is connected to the smaller sump and the line connecting the two sumps is closed. As can be readily seen from the general plan, other combinations are possible.

The main discharge lines supply groups of models located on three sides of the centrally-located pump house. Spiral welded pipe 12 in. in diameter is used for these main lines. An orifice meter, calibrated in place, is inserted in the line leading to the lock models, while a commercial venturi meter is located in the main supply line leading to the other models. For some models, V-

4. Size and shape of intakes, model scale 1:20

After developing the designs of various parts of the hydraulic system, the proposed design of the complete system is tested by means of hawser-stress measurements in a general lock model. Two flumes for testing complete hydraulic systems on a 1:25 scale of the Third Locks have been constructed in order to expedite testing. Changes may be made on one model while tests are conducted on the other. A complete model of one of the old locks also has been constructed on a scale of 1:25. The hawser stress measurements for the Third Locks design are compared directly with the measurements on the model of the existing locks. The latter in turn are compared with field measurements on the prototype.

Surge tests are conducted by means of a model of Gaillard Cut. Some explanation is required to understand the necessity for these tests. The surges result from drawing water through the relatively narrow Cut, which is 9 miles long. Surges are created at present by the operation of the old locks at Pedro Miguel. As the Third Locks approach channel will also connect with the Cut, the magnitude of surges will be increased unless special preventive measures are adopted. The model was verified by identical tests conducted on the existing prototype. Two methods of controlling surges—scheduling lock operations, and the use of a surge reservoir—are being studied. The model, which is approximately

er Supply Line to Lock Models Runs from Pump (Right) Past Construction Office (Center)

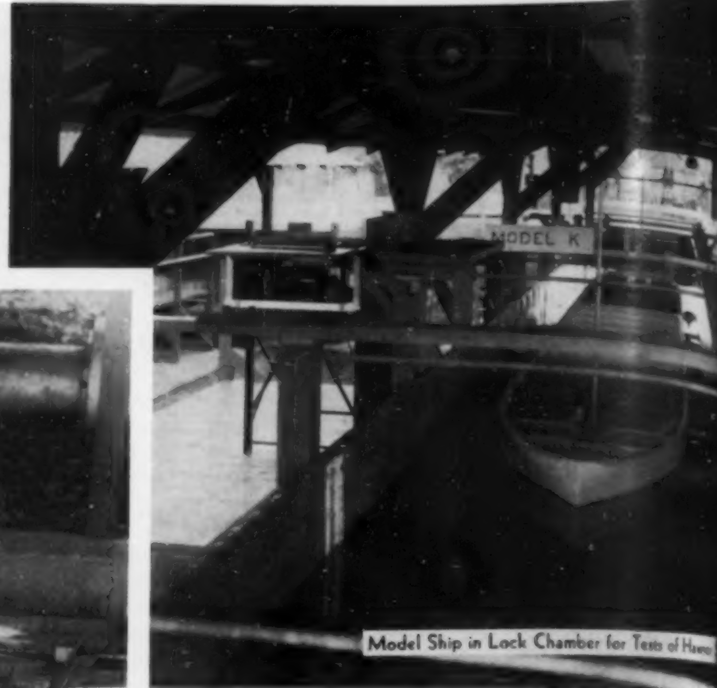
g, has been constructed to an undistorted scale The usual limitations of space and water sup- often make the selection of a distorted scale , did not govern in this case. It was more l to construct this model without providing a ch from the lock end to the sump; hence the unt of water used for lock operations is wasted. k approach studies were undertaken because sibility of saving considerable time in maneu- ips into the lock. In the existing canal, a large e of the time consumed in passing through a ed in entering the chamber. A model was con- to a scale of 1:60. Velocity distribution in the channel was observed for various types of out- bined with various lengths and angles of wing

ms that have been or are being studied in the eous group of investigations include: forces to operate miter gates, model scale 1:25; flow s in the channel at the toe of Gatun spillway us operating schemes, model scale 1:50; and cy closures for locks, model scale 1:50.

which controlled other studies, such as the gen- arch on manifolds, were started early, before the of the laboratory personnel were employed. However, the organization has been developed to conduct as many simultaneous studies as possible in order to meet a rigorous design schedule. Two-shift operation has been employed on some of the investigations.

The Hydraulics Laboratory is a part of the Hydraulics Section of the Special Engineering Division. This division has been organized to design and supervise the construction of the Third Locks Project. Colonel T. B. Larkin, M. Am. Soc. C.E., supervising engineer, is chief of the division, assisted by Lt. Col. Hans Kramer, M. Am. Soc. C.E., assistant supervising engineer. E. E. Abbott, designing engineer, is in charge of all design, assisted by J. E. Reeves, Assoc. M. Am. Soc. C.E., assistant designing engineer. The writer is chief of the Hydraulics Section, assisted by Edward Soucek, Jun. Am. Soc. C.E., hydraulic engineer. M. J. Webster, Assoc. M. Am. Soc. C.E., associate hydraulic engineer, is head of the Hydraulics Laboratory.

General Lock Models Fed by Water Supply Pipe Line



Model Ship in Lock Chamber for Tests of Haw

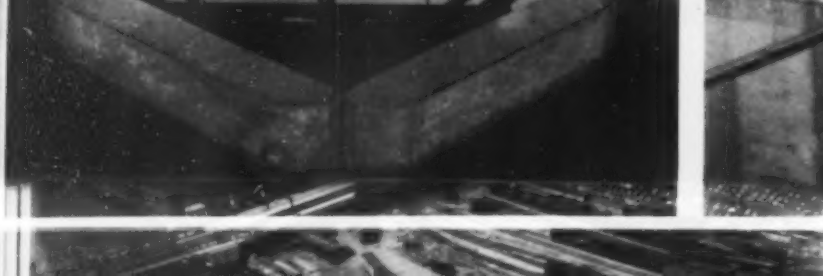
Model for Measuring Forces Required to Operate a Tainter Valve

Laboratory Shop — Machine and Sheet Metal S

Model of Gatun Spillway in Operation

Model for Determining Forces Required to Operate a Miter Gate

Ports of Manifold Test Apparatus, with Main Conduit Removed



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larger sump. A small electrical distribution house stands between the pump house and the smaller sump. The suction line to the smallest pump can be changed readily from one sump to the other. Interconnections are arranged so that the three pumps can be used to supply a single model, or the valves can be operated so that each pump can supply a separate model. The smallest pump can provide an entirely independent system when its suction line is connected to the smaller sump and the line connecting the two sumps is closed. As can be readily seen from the general plan, other combinations are possible.

The main discharge lines supply groups of models located on three sides of the centrally-located pump house. Spiral welded pipe 12 in. in diameter is used for these main lines. An orifice meter, calibrated in place, is inserted in the line leading to the lock models, while a commercial venturi meter is located in the main supply line leading to the other models. For some models, V-notch weirs are installed. Tees have been placed at suitable locations in the main lines for connections to existing models and for possible additional studies. The models have been grouped so that the operation of one will not interfere with that of the others. For example, the general lock models are located in one group which can be supplied ordinarily by the largest pump. Operation schedules are arranged so that not more than one of these models is operated at a time. This plan has worked successfully and has eliminated the necessity for a constant-head tank.

The models have been substantially constructed so that they can be left in place for further testing at a later date if desired. Additional tests may prove desirable, particularly after field tests have been conducted on the completed prototype.

Problems being studied in the Panama Canal Hydraulics Laboratory may be divided into four general types: (1) lock hydraulic system, (2) surges in Gaillard Cut, (3) lock approach channels, and (4) miscellaneous. As far as possible the lock hydraulic system is divided into separate items, and tests are conducted on each item before it is incorporated in the general lock models. By this method the number of tests and the number of major changes in the large general models are reduced to a minimum.

Tests for developing the hydraulic system are grouped as follows, and each group is studied by means of special apparatus or by an individual model:

1. Manifold research, model scale varied
2. Port and lateral connection shapes and sizes, model scale varied
3. Hydraulic forces on lock valves, model scale 1:20
4. Size and shape of intakes, model scale 1:20

After developing the designs of various parts of the hydraulic system, the proposed design of the complete system is tested by means of hawser-stress measurements in a general lock model. Two flumes for testing complete hydraulic systems on a 1:25 scale of the Third Locks have been constructed in order to expedite testing. Changes may be made on one model while tests are conducted on the other. A complete model of one of the old locks also has been constructed on a scale of 1:25. The hawser stress measurements for the Third Locks design are compared directly with the measurements on the model of the existing locks. The latter in turn are compared with field measurements on the prototype.

Surge tests are conducted by means of a model of Gaillard Cut. Some explanation is required to understand the necessity for these tests. The surges result from drawing water through the relatively narrow Cut, which is 9 miles long. Surges are created at present by the operation of the old locks at Pedro Miguel. As the Third Locks approach channel will also connect with the Cut, the magnitude of surges will be increased unless special preventive measures are adopted. The model was verified by identical tests conducted on the existing prototype. Two methods of controlling surges—scheduling lock operations, and the use of a surge reservoir—are being studied. The model, which is approximately

Main Water Supply Line to Lock Models Runs from Pump House (Right) Past Construction Office (Center)

800 ft long, has been constructed to an undistorted scale of 1:60. The usual limitations of space and water supply, which often make the selection of a distorted scale necessary, did not govern in this case. It was more economical to construct this model without providing a return ditch from the lock end to the sump; hence the small amount of water used for lock operations is wasted.

The lock approach studies were undertaken because of the possibility of saving considerable time in maneuvering ships into the lock. In the existing canal, a large percentage of the time consumed in passing through a lock is used in entering the chamber. A model was constructed to a scale of 1:60. Velocity distribution in the approach channel was observed for various types of outlets combined with various lengths and angles of wing walls.

Problems that have been or are being studied in the miscellaneous group of investigations include: forces required to operate miter gates, model scale 1:25; flow conditions in the channel at the toe of Gatun spillway for various operating schemes, model scale 1:50; and emergency closures for locks, model scale 1:50.

Tests which controlled other studies, such as the general research on manifolds, were started early, before the majority of the laboratory personnel were employed. However, the organization has been developed to conduct as many simultaneous studies as possible in order to meet a rigorous design schedule. Two-shift operation has been employed on some of the investigations.

The Hydraulics Laboratory is a part of the Hydraulics Section of the Special Engineering Division. This division has been organized to design and supervise the construction of the Third Locks Project. Colonel T. B. Larkin, M. Am. Soc. C.E., supervising engineer, is chief of the division, assisted by Lt. Col. Hans Kramer, M. Am. Soc. C.E., assistant supervising engineer. E. E. Abbott, designing engineer, is in charge of all design, assisted by J. E. Reeves, Assoc. M. Am. Soc. C.E., assistant designing engineer. The writer is chief of the Hydraulics Section, assisted by Edward Soucek, Jun. Am. Soc. C.E., hydraulic engineer. M. J. Webster, Assoc. M. Am. Soc. C.E., associate hydraulic engineer, is head of the Hydraulics Laboratory.

General View Shows Several Tiers of Bracing in the North Cofferdam and First Tier of Bracing Just Started on South Cofferdam

INCLUDING the bridge here described, Chicago has a total of 55 movable bridges over the Chicago and Calumet rivers and the Drainage Canal, 39 of which are of the Chicago bascule type. As far as its superstructure is concerned, the North State Street Bridge follows this general pattern, with improvements in details. Its substructure, however, presented unique problems because of the location of the new subway tubes just below the bed of the river at the bridge crossing. A system of subpiers to rock 103 ft below the normal river level carries the weight of the bridge so that none rests on the subway. Precise correlation was necessary in order to accomplish demolition of the old bridge, subway construction, and pier building for the new bridge, all at the same site.

Design and Construction of North State Street Bridge, Chicago

By Donald N. Becker, M. Am. Soc. C.E.
Engineer of Bridge Design, City of Chicago, Ill.

ON State Street at the northern edge of the so-called "Loop" district, the City of Chicago is now constructing a double-leaf bascule bridge over the Chicago River. State Street, the main retail shopping street of the city, is 120 ft wide on the south side of the river and 66 ft wide on the north side. At numerous times in the past a widening north of the river has been contemplated. In 1930 the city was planning to do this to a width of 115 ft in connection with the construction of a four-track subway. At the same time a new bridge was to be built of the proper width to accommodate traffic on the widened street. With the continuance of the depression, financing was found difficult. The plan contemplated was by special assessment against property combined with the public benefit bond issue of $2,500,000 voted in 1930. The cost of the bridge was entirely covered by a bond issue of $3,500,000 that had also been approved by the electorate in the fall of 1930.

Later it was decided to abandon or at least postpone the street widening but to build a wide bridge, in case the street should be widened during the 40 or 50-year expected life of the bridge. The 1930 plan for a four-track subway, to be financed largely by special assessment, was likewise abandoned. The two-track subway project that is now rapidly nearing completion, is being financed by a 45% grant from the PWA and the remainder from the city's traction fund, made up of payments to the city in accordance with the 1907 traction ordinance.

The new bridge is a double-leaf trunnion bascule of the so-called "Chicago type." It has a clear span between masonry of 210 ft, an over-all width of 108 ft, two roadways each with a width of 36 ft, separated by a center island 5 ft wide, and two sidewalks with a clear width of about 11 ft each. The bridge will be made up of three trusses of the so-called railing-height type, the top chord rising above the bridge deck to a height about equal to that of the railings. The center truss rises in the 5-ft island and acts as an effective barrier in separating traffic, and the trusses at the curbs keep pedestrians from jay-walking on to the roadways.

Underneath, the bridge is gracefully arched to provide a vertical clearance above normal water level of 20 ft for a width of 100 ft, and 16.5 ft for a width of nearly 160 ft, permitting free passage of tugs and barges while the bridge is closed. The elevation is shown in Fig. 1. In general the bridge has the same appearance as the Wabash Avenue Bridge, one block east, awarded first prize by the American Institute of Steel Construction as the most beautiful bridge completed in 1930 costing over $1,000,000.

On the north side of the river the foundations are being placed 70 ft to the north of those of the old bridge. This is so that a bend in the river at this location can be eased by rebuilding the dock walls along the north side of the river for a block each way from State Street.

Each of the movable leaves will have a weight of about 8,400,000 lb, carried on three trunnions resting in roller bearings, the first use of this feature in Chicago bascule bridges. The roller bearings will be equipped with spherical seats in the bearing housings so as to eliminate all possibility of binding. The trunnion for the center truss

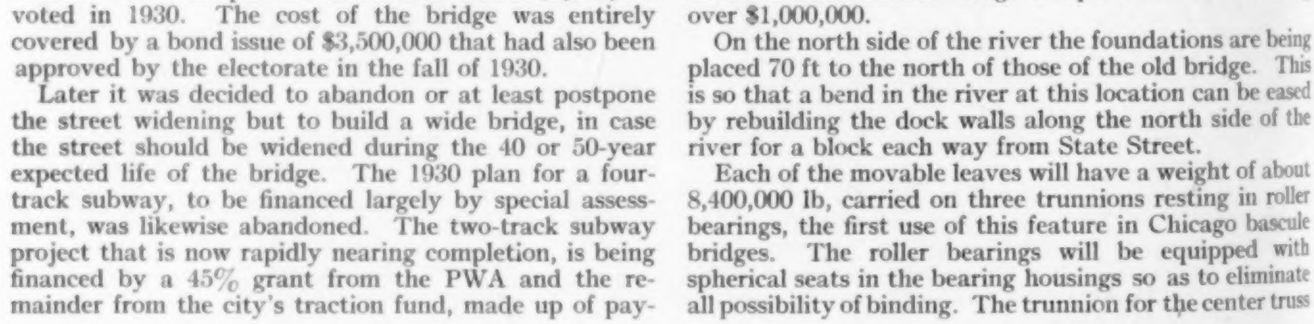


Fig. 1. Elevation of the North State Street Bridge

will be 31.5 in. in diameter and the other two 28.5 in. each. The leaves will be operated by electric-motor-driven gear trains driving through pinions meshing with racks in the two outside trusses only.

The floor on the bridge will be of concrete-filled I-beams $3^1/_2$ in. deep. The sidewalks will consist of asphalt plank $^3/_4$ in. thick, fastened to salt-treated Douglas fir planking attached to Douglas fir stringers. The main trusses will be constructed of copper-bearing silicon steel where stresses justify its use, and the remainder of copper-bearing carbon steel. There will be approximately 3,620 tons of steel in the bridge. The bridge trusses are designed to carry a continuous line of 50-ton street cars on a track in each direction adjacent to the center truss. For purposes of calculation this load is reduced to a uniform one of 2,000 lb per ft of track. Outside the tracks, the loading used is 125 lb per sq ft of roadway. To the live-load stresses are added proportionate impact stresses derived from the formula:

$$\frac{n}{n+2}\left(\frac{L+250}{10L+500}\right)$$

in which n = number of traffic lanes loaded, and L = the loaded length of the structure. The sidewalks are designed for a live load of 100 lb per sq ft.

No extraordinary features mark the superstructure but the substructure is characterized by several unusual conditions in design and construction. A sectional elevation of the foundation is shown in Fig. 2. It will be observed that the subway tubes are just below the bed of the river and the center line of the subway does not coincide with the center line of the bridge. The foundations consist of large concrete boxes, usually called tail pits, supported upon subpiers to rock at an elevation of about 103 ft below the normal river level. Because of the location of the subway, subpiers under the center truss, with its reaction of about 3,250,000 lb, were not feasible; neither was it possible to reinforce the front wall of the river piers with reinforcing rods. Accordingly structural steel trusses were fabricated and embedded in the walls to carry the loads to subpiers placed on each side of the subway tubes.

The former bridge at this location, a rolling lift built in 1903, crossed the river at the location shown by the dotted line in Fig. 1, and the masonry was supported on piles. As it was not feasible to construct the subway through these piles, it was decided first to remove the old bridge. Also it was decided that a correlated program for the removal of the old bridge, the construction of the subway tubes, and the construction of the new bridge was in order. Accordingly a joint schedule was determined upon and approved by the City Council, outlining the various items to be undertaken by the Department of Public Works and by the Department of Subways.

This program provided that the Department of Public Works should first contract for the removal of the old bridge. The removal of the superstructure was a simple matter but when the substructure in front of the south dock wall was reached, the problem arose of protecting the lower level of Wacker Drive from caving into the river when the bridge masonry was removed. Accordingly a wall of MZ-38 steel sheeting was driven down behind the masonry and anchored back by tie rods at the top to deadmen placed behind the third row of columns of the Wacker Drive viaduct. The sheeting was driven down well below the bottom of the proposed subway, so that the land section of the subway to the south could be built by the tunneling method up to this bulkhead and connection made to the river section by burning through the steel sheeting. This work was done by the Fitz-Simons and Connell Dredge and Dock Company of Chicago, in the summer of 1939.

After the old bridge was removed, the construction of the subway was undertaken by the Merritt-Chapman and Scott Corporation of New York, working for the city's Department of Subways. This contract was performed in two separate operations. First a trench was dredged in the bed of the river to the depth of the subway. Meanwhile a double-bore steel shell tube was fabricated a little less than 200 ft long, the ends bulkheaded, and sufficient concrete added to make the structure just float. The tube was then towed to the site, swung into place over the trench, and loaded with sufficient concrete blocks to make it settle gently into the trench that had previously been dug. It was lowered on to concrete seats built at the correct elevation near each end of the tube. To assist in its proper placement, steel alinement towers had been erected on each end of the tubes to such a height that their tops would be out of the water when the tube was resting on the bottom of the trench.

This work completed, steel cofferdams were constructed at each end of the tube to extend the subway each way to points back of the future bridge masonry. These cofferdams are indicated in Fig. 2. They were pumped out and braced as the water level was lowered. The top two sets of bracing were fabricated as steel trusses and dropped into place as a unit. After unwatering to the original bottom, the cofferdams were excavated down to the bottom of the subway tubes and the subway sections constructed from the ends of the sunken tube section to the back walls of the cofferdams, after which the remainder of the trench was filled with sand and clay. During this operation the subway contractor constructed the bridge subpiers that came within the area of the cofferdams. Upon completion of this work in the spring of 1940, the contractor did not dismantle the cofferdams but turned them over to the Department of Public Works.

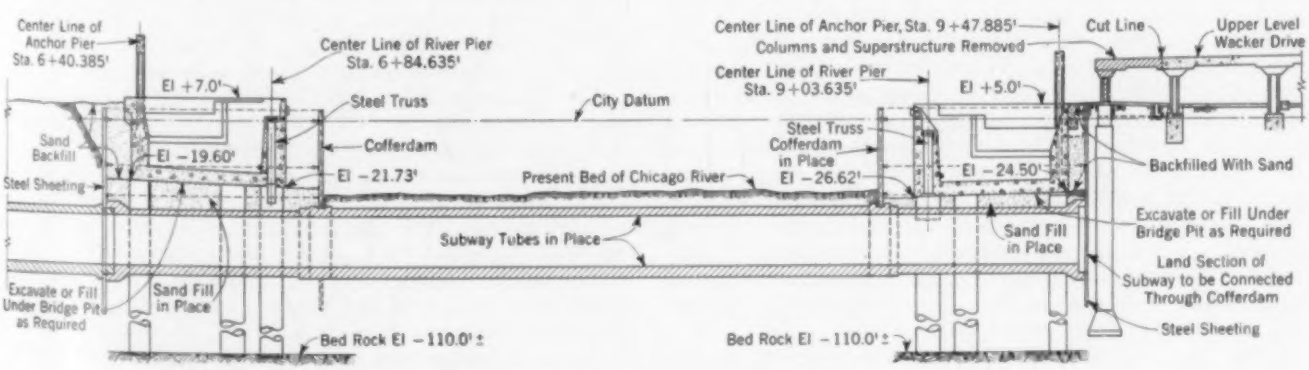


FIG. 2. SECTIONAL ELEVATION OF FOUNDATION, NORTH STATE STREET BRIDGE

REINFORCING TRUSS IN POSITION PRIOR TO CONCRETING SHOWS HOW TIMBER BRACING WAS SUPPORTED ON PIPE WHICH WAS LATER EMBEDDED IN CONCRETE

This department awarded a contract for the bridge substructure to the FitzSimons and Connell Dredge and Dock Company, which started work in May 1941. Previously it had awarded a fabrication contract to the American Bridge Company for the two steel trusses to be embedded in the masonry. These were fabricated at Gary in 1940. The anticipated construction program was to enlarge the subway cofferdam by additions east and west to enclose the entire masonry area, rebrace the enlarged dams, build the remaining subpiers and construct the masonry, erecting the steel trusses by entering the members through the bracing as best they could be entered. It soon became evident that this was a most difficult task. The contractor then hit upon the happy thought of assembling the trusses, weighing 83 and 75 tons, respectively, for the north and south sides, transporting them on scows to the site, lifting them by floating derricks, and depositing them in the subway contractor's cofferdams from which the bracing had been removed by divers. On the south side the two ends rested upon the subpiers previously built in approximately their ultimate location. One of the accompanying photographs shows this truss ready to be lowered into the cofferdam while the truss for the north side is on a scow.

On the north side there was only one subpier within the cofferdam and the truss was made of such length that its east end would rest on a subpier just outside the cofferdam. To accommodate this, a section of the side wall of the dam was removed and the truss set down with its east end shifted to the north a sufficient distance to permit the construction of the subpier, after which it was shifted to final location. When the trusses had been deposited in place, the cofferdam extensions were driven and the construction proceeded as previously outlined. After the sheeting for the dam was closed in, the old east and west walls of the subway cofferdams were burned away under water below the level of the new tail pits. The top tier of bracing was then set in place and pumping started. When the water level had gone down to the level of the next tier of bracing, the pumping was stopped and another tier was placed. This cycle proceeded until the dam was entirely unwatered.

The next step was to construct the subpiers by the standard Chicago open-cut method. Considerable water was encountered but was removed with pumps. The subpiers varied in size from 5 to 8 ft in diameter and were reinforced with a circle of $1^1/_4$-in. square bars spaced about 1 ft on centers near the periphery of the cylinders, with hoops of $^3/_4$-in. bars spaced about 2 ft on centers vertically above El.-60 and about 5 ft on centers below. On top of these subpiers the tail pit was constructed. First the steel trusses were located in their proper positions, then the bottom was graded and covered with 1-in. planking to make a hard dry surface on which to work. On this the reinforcing for the bottom of the floor was placed. When the floor, which is $4^1/_2$ ft thick, was concreted up to the under side of the top reinforcement, there was a delay of about 6 hours while this reinforcement was placed. Pipe jacks were set up on a suitable timber support below the floor of the pit. The pipes passed through the floor area, and a jack screw was inserted at the top of each pipe. After the pit was poured, the pipes were cut off and calked.

The pour contained about 830 cu yd and was made in one continuous run of about 36 hours. The concrete was mixed in two 1-cu yd paving mixers discharging into hoppers, from which it was buggied around the pit area. Forms for the lower sections of the walls were then built and concreted. Bracing, where it would penetrate the forms, was removed temporarily and replaced after the concrete had hardened.

Anchor columns to take the live-load uplift from the bumper at the shore end of the bridge were buried in the rear wall of the tail pit. To set these, the concrete was leveled off with a sidewalk finish at the proper elevation, the column placed, alined, and braced. Grillages and anchorages for the machinery gear trains were also embedded in the tops of the side walls. In setting all anchor bolts, stove-pipe sleeves were placed around their upper sections so that it would be possible to adjust the position of the parts placed on them for correct alinement.

Inasmuch as concreting of a tail pit could not be monolithic, precautions were taken to make the joints as tight as possible by ample use of keyways and thorough cleaning of the concrete before more concrete was placed.

The bridge superstructure will be erected by the Overland Construction Company of Chicago and the electrical equipment installed by the Fries Walters Company of Chicago. These companies are now fabricating materials. A viaduct over the railroad tracks north of the bridge, with a lateral connection to North Wabash Avenue, will be built in 1942. Recently an A-3 priority rating was obtained for procurement of materials.

The bridge is being built by the Division of Bridges and Viaducts, Bureau of Engineering, of the Department of Public Works, with Oscar E. Hewitt as commissioner of public works, and W. W. DeBerard, M. Am. Soc. C.E., as city engineer. The project was under the supervision of Thomas G. Pihlfeldt, engineer of bridges, until his death in January 1941. It is being carried on by his successor, S. J. Michuda. The design was under the direct supervision of the authur, and erection is under the supervision of Clarence S. Rowe, M. Am. Soc. C.E., engineer of bridge constructon, with Carl O. Johnson in direct charge as resident engineer.

Coordinating Design and Construction on Chicago Subway

By Peter F. Girard, M. Am. Soc. C.E.

Assistant Chief Engineer, City of Chicago Department of Subways and Superhighways, Chicago, Ill.

In December 1938, Chicago started construction on a \$40,000,000 system of subways. The project has since been enlarged and the cost increased to \$57,400,000. Owing to unavoidable delays, operation is not scheduled to start until October 1942. Of special interest in connection with the project are the many problems involved in coordinating the design work with the methods used in tunnel and open-cut construction.

The design and construction of underground structures presents to the office and field engineer, as well as to the contractor, a great variety of problems—problems seldom encountered in work above ground—problems that demand a determination of the possible construction methods even before the design is started. The work here discussed, which is now nearing completion, consists of $8^3/_4$ miles of two-track low-level rapid-transit subway, connecting with and supplementing the facilities provided by the present elevated railroad system. This construction, which is known as the "Initial System of Subways," is the terminal portion of a comprehensive plan of about 50 miles of subways required to modernize and extend the rapid-transit system of Chicago.

The present work is being constructed in the area of greatest traffic congestion, the central business district, and consists of two routes (Fig. 1): (1) the State Street Route in State Street, Division Street, and Clybourn Avenue, linking the north and south-side elevated lines, and (2) the Dearborn Street Route, in Dearborn Street, Lake Street, and Milwaukee Avenue, connecting the northwest-side elevated lines with the downtown district. The present terminal is a loop in Congress Street. This route is to be extended west to connect to the two existing west-side elevated lines. The present construction is the most expensive and complicated that will be required in the entire system, as now planned.

In the years previous to 1938, the city had prepared various plans for subways, in tunnel and open cut, and one of these was the basis of negotiations for a grant from the Public Works Administration. On November 3, 1938, the city and the PWA closed a grant agreement providing for a radically different project, both as to routes and design, than that originally contemplated. The terms of this grant agreement included the following:

1. The work of construction must be started on or before December 15, 1938 (42 days away).
2. It must be substantially completed by June 30, 1940 (approximately 20 months away). (Congress has since extended this time to June 30, 1942.)
3. The routes of the subway were to be as have been described.

Subway building has long been recognized as one of the most difficult and dangerous types of construction, and the Chicago project has proved no exception to the rule. Heavy underpinning, subaqueous tunneling, specialized foundation problems, and the necessity of maintaining business as usual during the construction period were all further complicated by the urgent need for speed. Starting from scratch, an organization was assembled, designs completed, contracts let, and construction begun in a remarkably short time. Only a few years ago such speed would have been impossible. How it was obtained and the problems surmounted are recounted by Mr. Girard in this article taken from the paper he presented before the joint session of the Structural and Construction Divisions at the Society's Fall Meeting in Chicago.

Standard Tunnel Section of Horseshoe Type Is Used Outside Loop Area

These two routes included only a portion of the routes previously thoroughly designed, and only a small part of the completed studies could be used. Before this agreement was approved, the city was able to complete its survey of the traction problems involved, but only a general preliminary investigation of the engineering problems could be made of these modified routes, because of lack of time. The main problem at hand was to meet the starting date. Approximately 60 men were working on the project, in temporary quarters, when the grant was approved by the PWA.

From the very beginning of the planning of Chicago's subway system, it was apparent that a large-scale, high-speed project such as this would require a large department organized for this specific purpose, when funds were made available. However, these new conditions required such a rapid start that actually the first subway contractor began digging before the department could be firmly organized. In spite of this handicap the first contract of \$2,700,000 was advertised, and bids received on December 1. The work could have been started on the required day, December 15, and actually was started on December 17, a delay of only two days. The work was rapidly organized, and at the peak of construction a force of over 500 employees carried on the high-speed designing and field work necessary. During the year 1939, additional contracts totaling \$30,000,000 were awarded. As it was essential to perfect the organization of the new department, and at the same time complete the plans and specifications for several tunnel construction contracts, the first few months of 1939 were spent in these two efforts. The engineering organization formed consisted of four divisions: (1) administrative, (2) design, (3) surveys, and (4) construction.

A glance at an aerial view of Chicago reveals even to the casual observer a definite localized area of tall buildings. A survey of foundation information provided the following data about these buildings:

1. Most of them were on spread footings.
2. Most of them were occupying the sub-sidewalk space.
3. Some, although on good foundations, had excavated for first, second, and sometimes third sub-basement space under the public walks

JUNCTION SECTION HAS TEMPORARY BULKHEAD TO PROVIDE FOR FUTURE CONSTRUCTION

4. In Dearborn Street, the tunnel walls would project a slight distance inside the curb walls, thereby providing an excellent chance for loss of air pressure from the tunnel into the sub-sidewalk spaces.

Added to these hazards was the fact that soil explorations indicated a soft and unstable soil over much of the downtown area, and the presence of a mass of utilities with many deep vaults.

Where the depth was suitable for tunneling, two methods were available for use—the bench method and the shield method. The former usually requires a horseshoe-shaped section, and the latter a circular one. Until the actual construction method was decided upon, the final design could not be completed. The major decision regarding tunnel shapes then became the choice between these two methods.

Because of the conditions that have been outlined, it was decided to use both methods on this project. For the downtown contracts, shields were specified while for the outlying sections of the initial system, the "open face and bench" method was chosen. The use of air pressure up to 15-lb gage was required in both methods.

The plans and profiles were prepared by a planning group in the Design Section, and when approved by the Administrative Section, were released to the structural, architectural, mechanical, and electrical subsections, for the preparation of bidding and construction plans. Many items of design had to be coordinated by these subsections, including ventilation, drainage, track, lighting, power supply, emergency exits, escalators, connections from stores to the subway, street restoration and station layout, finish, and equipment.

Each of these units has men well versed in theory and practice in their particular field, and one or more of these men were assigned to act as "trouble shooters" between the field and the office during the construction period. A Specifications and Estimate Subsection prepared all specifications and cost data necessary for advertising the work for bids. Specifications for 45 contracts have been written for this project.

The Surveys Section includes subdivisions charged with obtaining and correlating alinement and topography, soil information, and foundation data. Alinement survey parties work closely with the design alinement subsection. With the construction divided into numerous contracts proceeding simultaneously, accuracy in surveys and computations was of paramount importance.

Foundation surveys were made of all existing buildings along the subway routes. All available data from architects, owners, and building maintenance organizations were collected and placed on file. These were supplemented by complete dimensional surveys of the basements, sub-basements, and lower floors. As a further record of conditions before, during, and after construction, over 30,000 photographs were taken of the exterior and interior of the 2,000 buildings involved. These photographs provide a factual record of any disturbance that occurred during or after construction, and will be invaluable to the city as a protection against unjust claims for damages.

The Construction Section includes a Construction Supervision Subsection, having resident engineers on each contract, with field offices convenient to the site of the work. Supervising the work of these residencies is a chief construction engineer and a group of assistants in the main office of the department, where construction problems, anticipated or unexpected, can be immediately discussed with the members of the Design Section.

Other subdivisions of the Construction Section consist of an Estimates and Records Subsection, in which are prepared monthly estimates of completed work for periodic and final payments to the contractors, a Testing and Inspection Subsection, and a Safety Subsection.

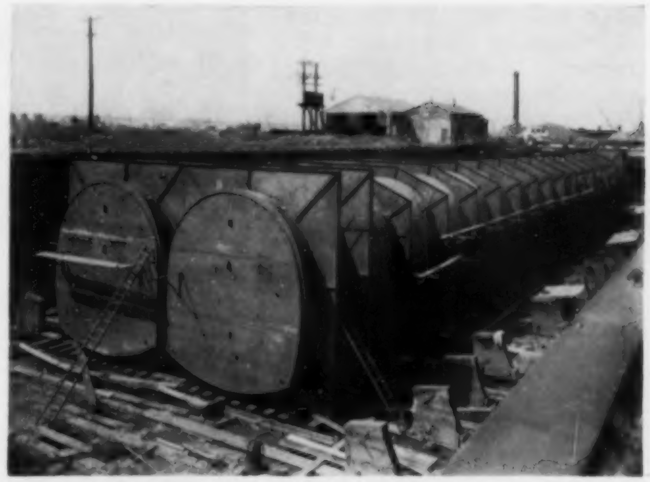
Construction of the Dearborn Street route was complicated by the following considerations:

1. The caissons of the Lake Street Bridge were too close together to allow two adjacent tubes to pass between them at the same elevation. It was necessary

to place one tube north of the bridge on private right-of-way. Just west of the river, a junction was required on each tube at different levels, to avoid a grade crossing for the future extension of the subway in Lake Street. To accomplish this the north tube passes beneath the south tube at this point. The north tube reaches a depth of 90 ft below the street grade.

2. In determining the limits of shield-driven tunnels on the Dearborn Street route, an interesting construction consideration entered into the design, owing to the presence of a street-car tunnel across the route of the subway at LaSalle Street and Lake Street. The use of this tunnel, which crosses the Chicago River at LaSalle Street, had been largely discontinued, because of far less frequent interruptions in surface traffic due to open bridges. The elevation of this tunnel at Lake Street was approximately the same as that of the proposed subway. The entrance portal of the old tunnel was in the block immediately south of the subway route.

Since the building of the subway necessitated the temporary, or possibly permanent abandonment of this tunnel, it was recognized as an excellent site for a contractor's plant. It should, if possible, be the starting or shoving-off point of the shield construction. LaSalle Street thus became the west limit of shield construction on this route, and the contractor quickly noted the advantage of using the tunnel portal as a plant site and for the assembly of the shields. The island-platform section at the Clark-LaSalle Station was built partly by the shield method and partly by the bench method. This street-car tunnel is now blocked, but it can be changed in grade at the south portal and made available for use.



Prefabricated Steel Tunnel Section Was Placed in a Trench in the Chicago River

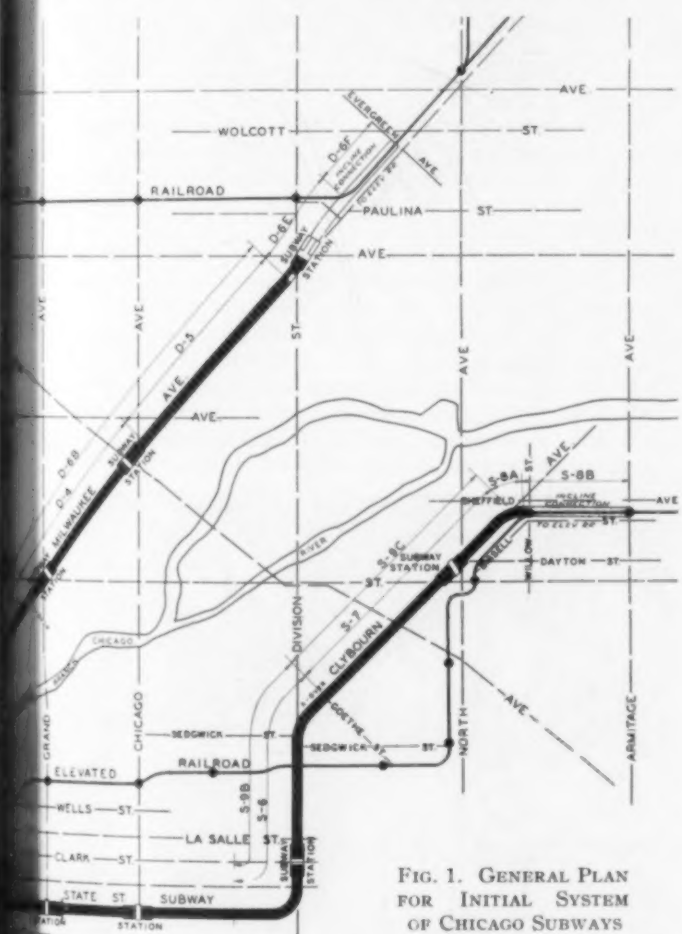


Fig. 1. General Plan for Initial System of Chicago Subways

Two river crossings were included in the Initial System of Subways—one on State Street, and one on Lake Street. Methods of construction at these crossings were largely determined by the subway profile. On Lake Street, the nearest station platform terminated at Wells Street, far enough from the river crossing so that a 3% downgrade to the river brought the base-of-rail elevation low enough to allow crossing the river by the conventional "open-face and bench" method of mining. With a minimum of 16 ft of stiff clay overhead, the tunnel was completed without any unusual amount of seepage.

At State Street the nearest station platform was too close to the river to allow a deep river crossing without producing excessive grades in the subway profile. In fact, the profile indicated a river crossing section submerged only a few feet below the river bottom. Consequently, this section was designed to be built in dry dock, floated and towed to the site, and sunk into a trench excavated by dredging in the river bottom.

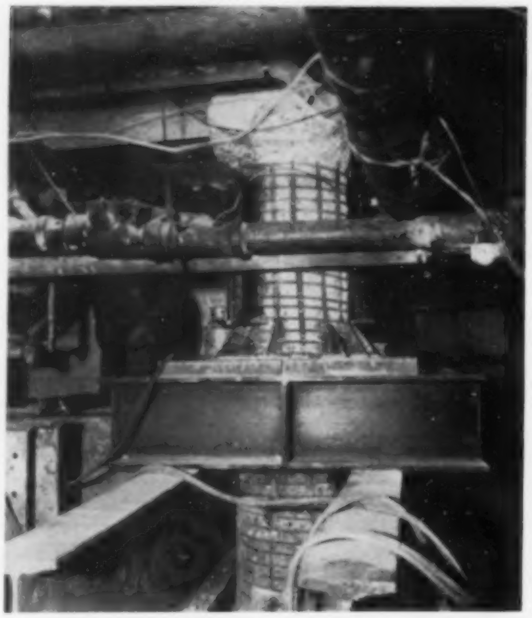
Computations of buoyancy showed that the river crossing section would have to be about 50% heavier than the normal twin-tube land section to prevent uplift after dewatering. The section was formed of two welded steel-plate tubes stiffened and fastened to each other by steel diaphragms, encased in concrete both inside and outside the tubes. The entire lining inside the tubes and the bottom and a portion of the side of the exterior concrete was poured in drydock. Steel bulkheads sealed the ends of the tubes. The structure, approximately 200 ft long by 40 ft wide and 23 ft deep, with an average draft of 18.17 ft, was then towed from its drydrock on the Calumet River a distance of 18 miles to the State Street site. After sinking, the remaining concrete encasement was placed over the top of the tubes by the use of a tremie.

Connections between river and land sections were accomplished in cofferdams at the river banks. To provide a watertight connection between the ends of the river crossing and the cofferdam walls, steel pockets were formed in the exterior concrete of the river tubes into which the next adjacent sheet piles of the cofferdam were driven. The pockets were then sealed by filling with tremied concrete.

Since the city was planning a new State Street Bridge, the design and construction of the State Street river crossing had to be coordinated with bridge construction, and portions of the bridge sub-piers close to the subway

tubes were built in the same cofferdams by the subway contractor. Special sheet-piling connections were left by the subway contractor for subsequent enlargement of the cofferdam by the bridge contractor. [For details of the bridge construction see the article by Donald H. Becker in this issue.]

At a number of points along the subway routes, the tubes had to be constructed across private property, and involved in the acquisition of easements at these points were a number of special underpinning problems. At the corner of Lake and Dearborn streets, the shield-driven tubes had to pass under the Harris and Selwyn theaters on a 300-radius curve. As a part of the agreement between the city and the property owners, a new foundation had to be built, consisting of foundation girders and sub-piers resting on hardpan. Extreme care had to be exercised in the alinement and survey work, because of the necessity for short sight distances and piecemeal construction. The underpinning had to be done from the basement of the building. Afternoon and evening performances were being given in each of these theaters, and it was necessary to maintain all utilities and services in the buildings, including basement dressing rooms. A carefully worked-out sequence of girder placement had to be adhered to in order that the placing of one would not block the placing of another. After completion of the new foundation, the subway shields were edged through between the sub-piers with only a few inches of clearance.



HEAVY UNDERPINNING TRANSFERRED CONCRETE COLUMN LOAD TO NEW CAISSON

Most of the mezzanine stations are rectangular structures with their floor level about 18 ft below the street level, and connected to openings in the roof of the platform arches by sloping stair and escalator passages. Consideration was given during the design studies to the construction of these stair passages by tunneling on a slope from the lower edge of the open cut required for constructing the mezzanine station. The length and depth of these passages, however, made it slightly more economical to remove the overburden of earth and construct them entirely in open cut. In the future subways—some of which will have train platforms at greater depths, the use of tunneling for these stair and escalator passages may be found economical. Most of the auxiliary structures, such as pump rooms, emergency exits, and ventilating shafts, extend from the ground surface to or below the level of the train tubes. In deep excavations such as these, it was recognized that wherever possible the structures should have a circular pattern to facilitate sheeting. One of the pump shafts adjoining a river crossing, for instance, was 90 ft deep.

Emergency exit structures for the subway sections having parallel separated train tubes at equal depth were built in a rectangular pattern because of space limitations between the tubes. In many places, however, the single-track tubes were at different elevations and had varying space between them, or were joined in a twin structure. In these instances, each tube had its own exit structures offside, and circular shapes could be used. The circular exit shafts were 10 ft in internal diameter, fitted with the lighthouse type of stairway, using half-circle concrete stair landings at 10-ft intervals vertically, and steel spiral stairs making half a revolution between each pair of landings.

The ventilation of the tubes is dependent upon the piston action of the moving trains. This requires exhaust and intake structures along the route at about 450-ft intervals, and having a free cross-sectional area of air flow of approximately 100 sq ft. These structures are known as ventilating shafts. At the incoming-train ends of the station, these areas were doubled to reduce the wind blast on the platforms. It is desirable that the horizontal plan of these shafts be long and narrow to allow for the maximum practical number of connecting wall openings in the tubes. A deep, narrow rectangular structure for this purpose would have a high unit cost due to the excessive amount of sheeting and bracing required.

After some study a standard design was adopted, having a battery of three or more circular shafts, each 5 ft 9 in. in inside diameter, connected at the bottom to each other and to a series of four wall openings in the tubes. At the upper ends of these shafts—in shallow cut—the tubes terminate in a rectangular box structure with open grating at the sidewalk surface.

For the blast-relief shafts at the ends of station platforms, the number of shafts per structure was increased to eight. Here the circular-well construction proved not only economical to put in, but also efficient from the standpoint of air flow.

Nearly all the contracts for subway work have included a provision which allows the contractor to submit construction methods of his own choice for approval. On crossovers the contractor has had the choice of open-cut or tunnel construction. After the award of a contract, all working plans were coordinated with the construction method involved. As a result, much additional knowledge has been gained for both the designer and the builder of underground structures in Chicago.

THE ISLAND PLATFORMS AT ROOSEVELT ROAD WERE BUILT IN OPEN CUT

Building the Angeles Forest Highway

Route Across the Previously Insurmountable San Gabriel Range Connects Los Angeles, Calif., with Agricultural Area to the North

By E. A. BURT, M. AM. SOC. C.E.
CHIEF DEPUTY ROAD COMMISSIONER, COUNTY OF LOS ANGELES, CALIF.

A DRIVER traversing the 25 miles of scenic Angeles Forest Highway can readily see why it took twelve years to plan and build. Here a highway has been constructed through mountainous terrain using the most advanced methods of location, bank protection, fill and culvert construction. Without modern construction equipment it would have been an almost impossible task. As it now stands, it is a tribute to the skill of the engineering profession and to the initiative of Californians.

FOR the purposes of this article Los Angeles County may be considered as a rectangular piece of land sixty miles wide and sixty-five miles long. Across this rectangle, roughly in a northwesterly and southeasterly direction, there runs a range of mountains, the San Gabriels. The higher peaks reach an altitude of 6,000 ft, and a few rise as high as 10,000 ft. These elevations, with climatic conditions, cause the range to be snow covered during several months of the year.

Since the beginning of western explorations, this mountain barrier has constituted a serious obstacle to travel northward from the Los Angeles area. Fremont Pass about ten miles from the western boundary of the county, provides the only natural outlet to the north. Originally explored by Gen. John C. Fremont on 1842, it has been in use for a hundred years. It was first developed by a steep and narrow cut, then by a tunnel, and recently by a modern high-standard highway. From this pass eastward to the county boundary, the San Gabriel Range presented an insurmountable barrier to travel until the opening of the Angeles Forest Highway.

The need of an additional route across the mountains is apparent when it is considered that there is on the south side a vast metropolitan region including the cities of Los Angeles, Pasadena, Glendale, Long Beach, and nearly forty others, while on the north is a vast agricultural area, called Antelope Valley. The advantages of a link between these areas were recognized in 1915 by the California State Legislature, when it authorized the making of a survey for a new, more easterly route. The report presented to the State Highway Commission in March 1917 indicated that the project would be of such magnitude—and consequent cost—that the possibility of its accomplishment was extremely remote. However, persistent effort on the part of public and private organizations, coupled with progress in construction methods and increased availability of road funds, brought this seemingly impossible project to completion in a period of thirty years. A location map appears in Fig. 1.

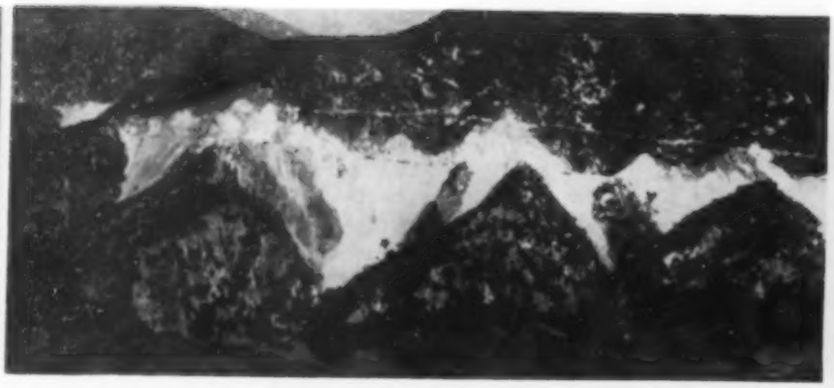
The Angeles Forest Highway has a length of 24.09 miles. It extends from the Sierra Highway on the north to the Angeles Crest Highway on the south. The total width of graded road is 32 ft, which provides two 13-ft lanes for traffic and graded shoulders 3 ft wide on each side. Five million cubic yards of excavation were involved in its construction. The maximum grade is 7%, and the minimum radius of curvature, 300 ft. The highest elevation reached is 4,903 ft above sea level. It has been under construction for a period of 12 years.

FIG. 1. LOS ANGELES COUNTY SHOWING LOCATION OF ANGELES FOREST HIGHWAY

Among its many interesting features may be listed:

1. The reinforced concrete arch bridge which carries the highway across Big Tujunga Canyon, in itself a structure of monumental proportions.
2. The cross section of the roadway, designed to provide a particularly safe driving width and also to ensure the effective control of surface drainage.
3. The method of constructing exceptionally deep fills and the layout of culverts in precipitous canyons, which appear to offer an effective solution for problems of this type.
4. The planting of all fill slopes to prevent erosion and reduce the scarred appearance of natural brush cover.
5. The source of all common labor—honor prisoners from the county jail.
6. Its really magnificent recreational and scenic advantages, which are in addition to its practical usefulness.
7. Use of aerial surveys for the more rugged portions of the route, a valuable and effective procedure.

The Big Tujunga Canyon Bridge is a reinforced concrete, solid-ring-type arch, with a span of 245 ft between foundations. The roadway is 185 ft above the stream bed, is 24 ft



CUT-AND-FILL CONSTRUCTION FOR MOUNTAINOUS TERRAIN ELIMINATES COSTLY MAINTENANCE WHERE ROADS FOLLOW CONTOURS

PIONEER OR CONSTRUCTION ROADS PARALLELING AND A[illegible] FINISHED GRADES WERE BULLDOZED OUT OF THE HILLS

BIG TUJUNGA CANYON BRIDGE HAS SPAN OF 245 FT AND STANDS 185 FT ABOVE STREAM BED

CAREFULLY CONSTRUCTED FORM WORK W[illegible] IN BUILDING BIG TUJUNGA CANYON BR[illegible]

IN RESTRICTED LOCATIONS STREAM CHANNEL CHANGES WERE NECESSARY

PAVED, INVERTED SHOULDERS CONTROL DRAINAGE AND ACT AS SAFETY ZONE FOR VEHICLES

WHERE NECESSARY TO HANG ROAD ON THE HILLSIDE, MASONRY WALLS WERE USED FOR SUPPORT

CULVERT HEADWALLS ON THE ANGELES HIGHWAY WERE MADE OF RUBBLE MASONRY

wide, and has two sidewalks with ornamental railing. The approach structure consists of one 64-ft and two 60-ft reinforced concrete girder spans. In the design of the bridge, analytical procedure was used, followed by model elastic analysis, using the Beggs deformeter. Foundation conditions were particularly excellent as native rock was exposed on both faces of the canyon.

The traveled roadway is 26 ft wide, measured between flow lines of gutters. Its full width is made usable by the so-called "inverted" shoulders, which are 3 ft wide and slope upward at the rate of 3 in. per ft. They are surfaced with an oil mixture of natural material in the same manner as the roadway surface, thus providing an effective method of holding surface drainage on the road until it can be discharged, at frequent intervals, at points which are protected against erosion. In addition to effectively controlling drainage, this type of shoulder offers several safety features to vehicles and gives drivers a feeling of security which is important on roads of this character. The provision for holding surface drainage on the roadway also materially helps in preventing wash-outs due to landslides, which cause serious stoppage of drainage flow. The unprecedented rainfall of January to March 1941 was a particularly trying test of this type of section, and its completely satisfactory operation under such severe conditions was extremely gratifying.

Past experience in the location of roads in rugged country indicates the desirability of eliminating side-hill construction wherever feasible. As a consequence, in so far as possible, cuts were made through ridges and the resulting fills were utilized to cross the adjacent canyons. This method eliminates much future maintenance expense due to sliding hillsides, and at the same time permits improved methods of handling runoff. On the other hand, it does create fills of considerable depth which are not easily consolidated. Since the progress of the work was comparatively slow, it was considered practical to use end-dumping in the construction of the fills, as any settlement could be later corrected. In many cases, the fills were about 100 ft deep. As the material contained a great proportion of large rock and boulders, complete segregation occurred in the dumping process. As a result, the lower levels of the fill consisted entirely of hard rocky material, while the upper levels were of the finer aggregate.

In placing culverts in these fills, much study was given to the proper elevation of the inlet above the canyon stream bed. Being very precipitous, these streams bring down large quantities of eroded material. After some trial and error it was found desirable to raise the inlet of culverts 30 or 40 ft above the stream bed, thus creating a small settling basin for the protection of the culvert structure. Some concern was felt as to the effect which hydrostatic pressure would have on the fill structure. Experience has proved, however, that the coarse rock base of the fills acts as an effective percolating medium, and very desirable results have been obtained by this method. Many of the fills have been in existence through three winters, with no indication of failure. Settlement has been very nominal, proving that this method is superior to construction in layers. A gradual filling in of the debris basins above the fill seems to insure the permanency of this type of fill.

The major part of the project is within the limits of the Angeles National Forest. Past experience of the Forest Service, as well as that of the County Road Department, indicated the need for some form of planting, not only to protect slopes but also to cover the scars made by excavation. Various forms of slope protection were tried, among them brush and straw wattles and various kinds of slope planting. The most effective treatment consisted of a rather close planting of Baccharis (a type of willow). Cuttings approximately 18 in. long and from $^3/_8$ to $^3/_4$ in. in diameter were planted at the beginning of the rainy season, usually November. In a matter of two years, the growth becomes reasonably heavy, prevents erosion rather effectively, and in a very agreeable manner covers up the scars made by construction.

For more than twenty years, the County of Los Angeles, through a cooperative arrangement between the Office of the Sheriff and that of the Road Department, has maintained honor camps for county prisoners, and the work of these prisoners has been utilized in building many miles of roadway, especially in mountainous areas. On this particular project the work was started with one camp of 60 men, and the force gradually augmented until three camps were in operation. Two of the camps were maintained with a personnel of sixty, and the third one with eighty. The equipment of the camp, the food, and the furnishings, as well as one paid chef, are provided by the Road Department. Prisoners are given a wage for each day worked, the amount being usually 50 cents.

Certain types of work, such as cutting brush, sloping fills, planting erosion protection, building masonry walls and other structures, and doing certain finished grading, have been found especially adaptable to this class of labor. Crowded conditions in the county jail make it advantageous to utilize prisoners on work of this nature. In many cases rehabilitation of men who might otherwise become hardened criminals has been reported. Of course most of the material is moved by machinery.

As the final survey progressed to the more rugged portions of the route, it became apparent that the time required for it would be excessive unless some improved procedure could be devised. Consultation with the Los Angeles office of the Fairchild Aerial Surveys indicated that the use of aerial surveys would solve the difficulty. From the aerial photographs, a belt of contours was developed approximately 1,000 ft wide, having a horizontal scale of 1 in. = 100 ft and a contour interval of 10 ft. An accuracy of under 5 ft in elevation was proved by subsequent checking. This survey was made by first developing a triangulation system and placing L-shaped targets (about 10 by 20 ft) on the ground at known elevation and position. These targets were clearly observable in the final photographs and were used in developing the contours in a stereopantograph. The areas involving serious error were those where tree cover obscured the natural ground surface; in such places contours were indicated by dotted lines. Upon the resulting contour map, the center-line location of the final roadway was projected in the usual manner. When the actual construction started, the center line, as developed on the contour map, was run out, cross-sectioned, and adjusted in any minor ways that were found necessary. Adjustments in general did not exceed 10 ft horizontally and vertically.

There has been much speculation as to the volume and type of traffic that will use this highway. While the grades are not excessive, they are generally of great length and involve considerable curvature. As a consequence, heavy trucking is not anticipated. There is no road in Southern California that presents more interesting possibilities as a scenic drive, and as a route to open up recreational areas. The project was officially dedicated and opened to the public on September 12, 1941. The immediate response in traffic volume completely justified the many groups that had advocated and worked for the construction of this highway over a period of more than thirty years.

Determining the Deflection of Structures with Models

By WILLIAM J. ENEY, ASSOC. M. AM. SOC. C.E.

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NUMEROUS published papers have described the use of simple elastic models of celluloid, steel splines, or brass wire, together with some type of a deformeter apparatus for the purpose of obtaining influence lines for shears, thrusts, moments, and reactions, or of studying stresses due to temperature deformation or foundation movements. Little, if any, attention has been given to the possibility of determining the deflection of the structure with the same model, although it can easily be done, as will be shown.

If the model of a frame structure is so proportioned that the moment of inertia of the model bears a fixed

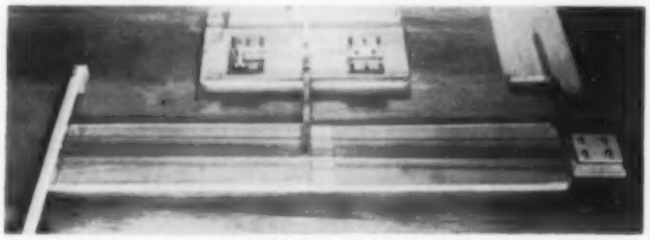

FIG. 1. CALIBRATION OF ELASTIC SPRING

ratio to that of the structure at corresponding sections, the following relationship exists between the deflection of the model and that of the structure:

$$\Delta_s = \Delta_m n^3 \left(\frac{I_m}{I_s}\right)\left(\frac{E_m}{E_s}\right) \quad \ldots\ldots\ldots \quad (1)$$

where

Δ_s = deflection of structure

Δ_m = deflection of corresponding point on model

n = units of length of structure represented by one unit of length in model

$\frac{I_m}{I_s}$ = ratio of moment of inertia of corresponding sections of model and structure

$\frac{E_m}{E_s}$ = ratio of modulus of elasticity of model and structure

This relationship is exactly correct whenever the deflection of a structure is primarily caused by flexure, and that due to direct stress or shear is negligible. This is the case with most building or bridge structures. However, some error is introduced in the case of machine frames such as C-shaped press frames, where the deflection due to shear and direct stress cannot be neglected. Even so, if the model is dimensioned so that not only the ratio of the moments of inertia but also the cross-sectional areas of corresponding sections are constant throughout, the relationship of Eq. 1 is still sufficiently exact for practical purposes.

DEFLECTION OF PLASTIC MODELS NOT EASILY OBTAINED BY APPLYING WEIGHTS

At first it would seem that if the modulus of elasticity of the model material were known, the deflection of the structure could be obtained by merely observing the deflection of the model under some load and then using Eq. 1. Indeed this is all that need be done if the model is of brass wire or steel splines. In such cases the modulus of the model material can be quickly determined by hanging a known weight on the end of a model cantilever beam, observing the deflections, and then calculating the modulus from the formula for the deflection. However, models are more frequently used to study structures of varying cross section, in which case sheet celluloid is used. Unfortunately celluloid models, although reasonably isotropic, creep annoyingly under load. For instance, the investigator is likely to find that the modulus of elasticity of celluloid has changed from 400,000 to 340,000 lb per sq in. in a 10-minute interval. Because of this difficulty, direct loading of a celluloid model to obtain the deflection of a structure involves inaccuracy.

ELASTIC SPRING OVERCOMES CREEP OF PLASTIC MODELS

This difficulty is easily overcome when an elastic spring equipped with multiplying levers is used to load the model. The details of one type of spring can be seen in Figs. 1 and 2. The spring consists of two parallel strips of celluloid rigidly clamped at their ends between brass plates so as to form fixed-end beams. To each of these beams there is attached a light aluminum lever pivoting about pins in a plate attached to one of the brass clamping straps. One lever is connected to a 1$^1/_7$ in. length of scale of 100 divisions per inch, which freely slides in a groove provided in the brass clamping plate. The other lever carries a pointer resting on the scale. The spring, which floats on steel balls, is placed between a rigid deflecting arm and the model to be tested. Rotating the deflecting arm applies a pull to the spring, which in turn pulls against the model. As the celluloid beams of the spring deflect under the pull applied to the spring, both the spring scale and the pointer are moved by the aluminum levers, thereby multiplying the beam deflection about 6 times.

As the spring and the model tend to creep toward each other, each to a certain extent offsets the effect of creep on the other. The creep in the spring is normally a very small amount; consequently the effect on the frame model is as though an initial force were applied to it and the model held stationary in that position by a rigid arm. An identical force can be applied to different models by means of the graduated scale on the spring. The elastic spring therefore serves a dual purpose: (1) it practically eliminates the annoying creep of models made of plastic material, and (2) it serves as a convenient means of applying an accurate force to the model.

FIG. 2. DEFLECTING FRAME MODEL WITH ELASTIC SPRING

This action of the spring in overcoming creep is illustrated in Figs. 3 and 4. When the frame model shown in Fig. 2 was acted upon by a load of 3.03 lb, the deflection increased at least 5% in 13 minutes, as shown in Fig. 3. However, when a slightly larger force was applied with the spring, as shown in Fig. 2, neither the spring deflection nor the frame deflection varied in a 20-minute period, as shown in Fig. 4.

LOADING FRAME AND CALIBRATION MODEL WITH ELASTIC SPRING

From Eq. 1 it can be seen that if identical forces are applied (1) to the model of a frame structure, and (2) to the model of a cantilever beam of constant moment of inertia, the ratio of the deflection of the frame model to the deflection of the cantilever beam model is equal to the ratio of the deflection of the frame prototype to that of the cantilever prototype. This is true only if both models have the same modulus of elasticity and are proportioned to the same similitude scales. Consequently if a force sufficient to deflect the cantilever model 1 in. is then applied to the frame model, the deflection of the frame model is identical to the deflection of its prototype when acted upon by the same structural force that will deflect the cantilever prototype 1 in. This structural force is easily calculated by conventional formulas. The following example illustrates the method.

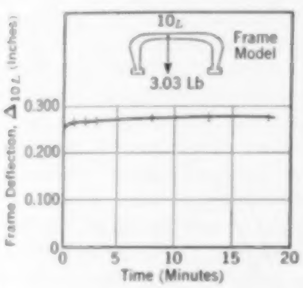

FIG. 3. EFFECT OF SUSTAINED LOADING APPLIED WITH WEIGHT ON FIXED FRAME

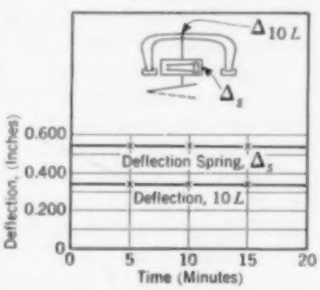

FIG. 4. EFFECT OF SUSTAINED LOADING APPLIED WITH WEIGHT OR SPRING ON FIXED FRAME

The prototype of the model frame shown in Fig. 2 was one of the steel rigid frames in a highway bridge of 96-ft 6-in. span, erected on City Line Avenue, Philadelphia, Pa., over the Pennsylvania Railroad. The model was laid out to a linear scale of 1 in. = 30 in. on a sheet of celluloid 0.125 in. thick. A width of 1 in. in the model represented a moment of inertia of 1.00 ft^4 in the structure. Complete details of this model and its prototype appeared in a discussion by the writer in the PROCEEDINGS of the Society for February 1941, page 315.

The model cantilever shown in Fig. 1 was 27.06 in. long and 1.250 in. wide, and was cut from the same sheet of celluloid as the frame model of Fig. 2. Its prototype is therefore a steel beam 27.06 in. $\times$ 30 $\div$ 12 = 67.65 ft long, with a moment of inertia of $\frac{1.250^3}{1.000^3} \times 1.0^4 =$ 1.953^4, laid out on the model to a linear scale of 1 in. = 30 in., and a moment of inertia scale of I:1 in. = I:1.0 ft^4. As shown in Fig. 5 (a) the deflecting arm attached to the spring was rotated until the end of the model cantilever deflected 1 in. The corresponding change in the spring scale reading was 0.540 in. The spring was then attached to the frame model, as shown in Fig. 2, and the deflecting arm rotated until the change in spring scale reading was again 0.540 in. (Fig. 5, c). The frame model deflected 0.273 in. under the same spring pull that

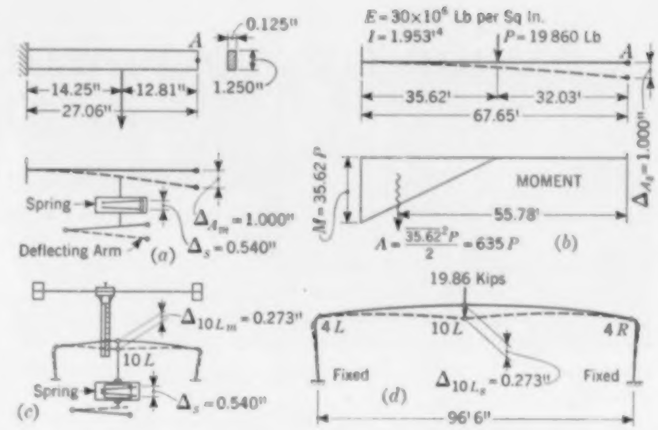

FIG. 5. DEFLECTION DIAGRAMS SECURED WITH ELASTIC SPRING
(a) Model Cantilever, (b) Prototype Cantilever, (c) Model Fixed Frame, (d) Prototype Fixed Frame

deflected the cantilever model 1 in. Therefore the structural force which would deflect the cantilever prototype 1 in. would deflect the frame prototype 0.273 in. This structural force is computed by the moment area principle to be as follows (see Fig. 5, b).

$$\Delta_{A_s} = \frac{635P \times 55.78 \times 12}{30 \times 10^6 \times 144 \times 1.953} = 5.04 \times 10^{-5} P \text{ (in inches)}$$

For Δ_{A_s} = 1.000 in., P = 19,860 lb. A pull of 0.540 in. on the spring, deflecting the prototype cantilever 1 in., is equivalent to a pull of 19.86 kips on the prototype frame, causing it to deflect 1.00 in. By proportion, then, the structure would deflect 0.0138 in. under a 1-kip load acting at the point of deflection, marked as point $10L$ in Fig. 5 (d).

The influence line for the deflection of the point $10L$ on the frame could now be found by displacing point $10L$ 0.0138 in. and observing the deflection of several points on the frame model. These small deflections would be difficult to read with an ordinary scale, and as the model was flexible a displacement of 0.786 was used. The deflection ordinates for a 1-kip load on the frame prototype were then found by dividing the observed deflection of each point by 0.786 and multiplying by 0.0138 in. By Maxwell's reciprocal theorem, the ordinates for the deflection of the frame prototype, when a 1-kip load acts at $10L$, are also the ordinates to the influence line for the deflection of point $10L$ due to a 1-kip moving load. Influence ordinates for the deflection of point $10L$, for a 1-kip load at 6 points on the left and 7 points on the right, consequently involved two scale readings for each point, a simple computation, and the introduction of a displacement at point $10L$. The displacement of the frame model of 0.786 in. at point $10L$ was induced by pulling alternately on the intrados and the extrados, substituting for the spring a link between the model and the deflecting arm. Previous investigation showed the deflection of the model to be the same for pulls applied to the intrados and extrados within the limits used.

The writer has used this method to obtain deflections of curved beams of variable cross section and the results agreed with the computed values within 2%. The method is fast and accurate, and almost no apparatus is needed. Variations of the elastic spring are possible—recent ones have been made entirely of celluloid. Only one calibration beam need be cut from a sheet of celluloid—and this calibration of the spring and cantilever model will serve for as many models as can be cut from the same sheet.

Major Improvement of St. Louis Airport for Defense

By William Judson Gray, M. Am. Soc. C.E.

District Manager, Work Projects Administration, St. Louis, Mo.

The Lambert Airport, official airport of the City of St. Louis, had expanded commercially in the early part of 1940 far beyond its existing facilities. The defense effort increased the gravity of the situation. Something had to be done immediately to relieve the growing congestion.

A new master plan was developed by the City of St. Louis and approved by the Civil Aeronautics Administration calling for the immediate construction of a new major runway of reinforced concrete with 6-ft shoulders of penetration pavement across the entire field, with additional runways planned for the immediate future. It was decided that the new major runway, in conjunction with the present system of runways, would greatly relieve the congestion and provide for greater defense activity than ever before. The runway was to be of such dimensions that the reinforced concrete required for its construction would be, in volume, sufficient to provide a 2-lane highway 9 miles in length.

A WPA project was set up for the construction of this runway, at an estimated cost of approximately $594,000, of which $115,000 was to be furnished by the Civil Aeronautics Administration, $159,000 by the City of St. Louis, and $320,000 by the Work Projects Administration. The plans also called for apron sections of the slab at locations along the runway where proposed future runways would cross the new runway, but these were not constructed because of possible changes in location of the proposed future additions. However, the approaches of existing intersecting runways with the new runway were brought up to the new grade. The existing runways were of penetration asphaltic pavement, and the new connecting sections were to be of the same type.

Work was started on the project in the early part of July 1941, and was 99% complete in the early part of December. The remaining work, consisting of seeding newly graded areas, has been postponed until spring. The runway was officially dedicated by the City and the Work Projects Administration on December 20, 1941, and was placed in service immediately thereafter. The time schedule called for a rapid rate of progress and completion by October 15, 1941. The actual rate exceeded expectations, and the work would have been finished on the scheduled date but for five weeks of lost time, the result of a prolonged rainy spell.

Approximately 127,000 cu yd of earth excavation, and 119,000 sq yd of fine grading were necessary to attain the final grade. Much of the earth for the fills that were required along the runway was obtained from stock piles of wasted earth from excavations for new buildings near the field. Approximately 14,000 ft of drainage sewers, ranging from 8 to 60 in. in diameter, including 192 catch basin inlets, were laid to augment the existing system and provide for the proper drainage of the new area of the runway.

After considerable study, the dry-batch method was adopted for the preparation of concrete. The average haul of the batches to the pavers on the runway was about 3,000 ft. The dry-batching plant, consisting of two units with two 1-yd cranes, was located a short distance from the main highway on elevated ground approximately 2,000 ft from the center of the runway. A short distance from the plant a large shed was erected for the storage of cement. Temporary roads were constructed from the main highway to these units and also to the runway.

The equipment used for concreting consisted of 2 road pavers, 2 finishing machines, and 6 bridges, including 2 for applying the burlap. City water was furnished for the pavers through a 4-in. temporary main extended from the city main on the highway about 6,000 ft away. Surfacing of the concrete was accomplished by a finishing machine with a tamper. Two vibrators were used for the joints. Long-handled floats were employed, followed by one belt finish ahead of the joint cutters, and a second belt finish behind the joint cutters. The concrete was laid in sections (two 10-ft lanes) 20 ft wide, 7 in. deep—ten sections in all, totaling 200 ft, the full width of the runway.

Reinforcing consisted of welded wire mesh on 6-in. centers, 4.7 lb to the square yard, set $2^1/_2$ in. below the surface. A patented steel interlocking joint was placed longitudinally in the center of each 20-ft lane for its entire length. It was fabricated with an open center which permitted concrete to flow through the joint. Punched holes, midway on 5-ft centers, provided support for $^1/_2$-in. by 4-ft transverse tie bars. The reason for using this special joint was to obtain a defined longitudinal separation or controlled crack midway of each section which would also provide an effective water seal.

Expansion joints were placed at 50-ft intervals in each section. This interval was chosen after taking into consideration temperature changes, soil conditions, and drainage. The

Road Paver Made an Average Daily 8-Hour Run of 1,351 Sq Yd Over a 10-Day Period

joint is a patented built-up dowel-bar assembly consisting of $^{3}/_{4}$-in. dowels spaced 12 in. apart, supported and spaced on three fabricated dowel spacers. The expansion material is $^{3}/_{4}$-in. cork. The alternate dowel bonding of the joint gave uniform dowel-bar stress on each side of the joint. This type of joint was designed to minimize cracking, confine slab movement, and keep the slabs in alinement.

At the transverse joints "hair-pin" bars were placed to strengthen the corners of the individual slabs.

All construction joints were tied, with the exception of longitudinal contraction joints. Two full contracting joints were installed longitudinally the entire runway length, one on each side, and 30 ft distant from the center line of the runway. This spacing of 60 ft between joints represented approximately the middle third of the runway. The shoulders of the runway—of penetration asphaltic pavement—are of rigid construction, 6 ft wide, and it was therefore deemed advisable to so space the full contraction joints. The joint was a patented built-up assembly type with the dowels supported and spaced on three fabricated spacers. Deformed dowel bars $^{1}/_{2}$ in. by 4 ft were placed transversely on 5-ft centers in each section, 2 ft of the length extending into the adjacent section.

The finished surface of the concrete runway has a fall of $14^{1}/_{4}$ in. for the 100 ft on each side of the center line, conforming to a parabolic curve. The curve has a drop of $^{3}/_{4}$ in. in the 10 ft on each side of the center of the runway. The remaining surface conforms to a tangential plane from the 10-ft point to the outer edges.

An approved type of subgrade paper was used. The writer considers this subgrade seal as one of the most important factors of the construction work on the runway, as it saved labor costs and delays, and was instrumental in producing a satisfactory concrete yield. The intense summer heat dried out the sprinkling on the finished subgrade ahead of the paver almost immediately, leaving it readily absorbent. This was demonstrated on one short stretch where no subgrade paper was used. The concrete set so fast that the finishers who followed the paver barely had time to give the final belt finish, and could not do a satisfactory job. The trouble was eliminated with the use of the subgrade paper, which kept the concrete from setting for nearly an hour after the pour, thus allowing ample time to obtain the specially desired finish. In addition to this advantage, initial handling of the concrete was facilitated, thereby saving labor costs and causing the actual cross section filled with concrete to closely approach the designed cross-sectional area of the slab.

Subgrade Paper Was Placed on the Finished Fine Grade Prior to Concrete Placing

A Finishing Machine with Tamper Was Used for Surfacing the Runways

Concreting started with one paver on July 28, 1941, and it was not until August 5 that the other paver was added. The paving was done in 10-ft sections—one-half of the 20-ft slab section. The daily average 8-hour run of the one paver over a ten-day period was 1,351 sq yd. For the two pavers over a ten-day period, the daily average 8-hour run was 2,714 sq yd. The concrete was cured under burlap for a period of seven days, during which time the burlap was kept wet 24 hours a day.

The actual yield of the concrete was 101.4% of the theoretical yield, indicating the continuous careful planning and operation of the field work. One contributing factor was the extreme care taken in the preparation of the subgrade. In the original cost forecast, the concrete was estimated at $2.31 per sq yd. The final figures show that the actual unit cost was $2.20 per sq yd—a saving of $11,500. The omission of the proposed concrete aprons to the runway resulted in a reduction of $53,700. Other savings, many due to lower unit construction cost, resulted in a total net saving of $50,000. The final cost of the work amounted to $477,305.

All the work was carried out without interfering with the operation of the airport. A whole-hearted spirit of cooperation was manifested throughout the job. There was no hard driving of the men, but the spirit of defense was a motivating force. Labor was supplied by colored workers who were thoroughly experienced in concrete paving. With their fine spirit of workmanship and the services of an able superintendent, the project was completed to the satisfaction of all.

The elements that characterize the work as an advance in this type of construction are:

1. Stabilization of the subgrade, which was carried down to firm earth so that it would be solid and unyielding.
2. Use of subgrade paper to retain the moisture in the concrete and prevent its partial absorption by the dry subgrade.
3. Use of specially designed center, contracting, and expansion joints which effectively stabilized and confined slab movement and produced engineering economies.

The design of the runway was under the direction of L. A. Pettus, M. Am. Soc. C.E., formerly civil engineer for the City of St. Louis. The writer had general supervision of the construction of the project, together with Swan McDonald, director of operations for this district. John J. O'Neill was the chief area engineer, assisted by Joseph McMahon. The actual construction was under the immediate direction of Jack Hall, general superintendent for the Work Projects Administration. Harold Horan was the project engineer representing the City of St. Louis on the work.

Solving Reservoir Problems with Circular Point-by-Point Computer

By J. M. Shepley *and* C. B. Walton

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FOR the solution of many reservoir and allied problems, the writers have developed a simple and inexpensive instrument, patterned after the circular slide rule. It is useful for such problems as routing flood waves through reservoirs with orifice or weir-type outlets; determining the size of spillway required to pass a "design flood" without the reservoir level's exceeding a given elevation; finding the amount of prime power available from a hydroelectric project as determined by the lowest seasonal flow and the available reservoir storage; computing the energy available from tidal power plants; placing hydroelectric plants which have seasonal storage on large system loads in order to obtain the maximum dependable capacity from the equipment; and routing power waves down rivers. These problems are usually handled by point-by-point computations using cut-and-try methods in tabular form, graphical methods, integrating machine methods, and others. The cut-and-try methods are laborious and time consuming; the graphical methods known to the writers are comparatively tedious and cumbersome; and the integrating machine methods require expensive equipment, special recording graph paper, and trained personnel.

DESCRIPTION OF THE INSTRUMENT

The instrument (Fig. 1) consists of two celluloid index arms, A and B, mounted on a circular percentage-protractor so that each arm and the protractor are free to move relative to one another, and a work board. To facilitate the drawing of concentric circles with the center of the protractor as their centers, and to enable angular distances to be marked off along these circles, a group of holes are drilled along the index line C, on index arm A. The screw assembly fastening the index arms to the protractor is such as to act as a center guide and a punch for the paper mounted on the work board over the center guide hole.

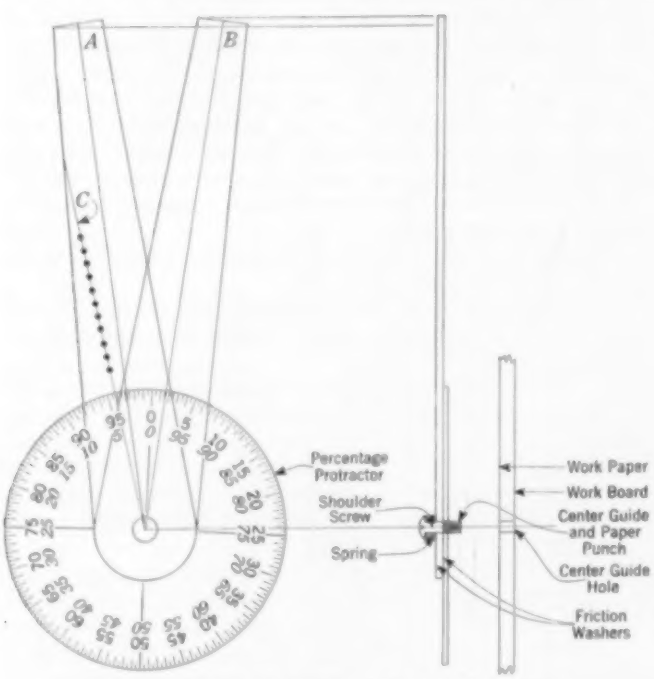

Fig. 1. Circular Point-by-Point Computer

Table I. John Doe Dam—Reservoir Volume and Spillway Discharge Versus Reservoir Pool Elevation

El. of Pool (Ft)	Reservoir Volume (Cfs − days × 10^{-6})	Spillway Capacity per Gate (Cfs × 10^{-6})
350	0.588	0.0040
351	0.607	0.0048
352	0.629	0.0056
353	0.654	0.0062
354	0.672	0.0070
355	0.694	0.0080
356	0.716	0.0086
357	0.739	0.0092
358	0.763	0.0100
359	0.787	0.0110
360	0.810	0.0120
361	0.835	0.0128
362	0.859	0.0136
363	0.883	0.0146
364	0.908	0.0156
365	0.932	0.0164
366	0.956	0.0172
367	0.981	0.0182
368	1.005	0.0192
369	1.029	0.0202
370	1.053	0.0212

To illustrate how the instrument is used, consider a simple example of a hydroelectric project consisting, among other things, of a reservoir and ten equal spillway gates. The reservoir volume and spillway capacity of one gate in relationship to the elevation of the reservoir pool are shown in Table I for fluctuations from 350 to 370 ft. It is required to find, for a given inflow flood hydrograph, with all the gates thrown open, (1) the fluctuation of the reservoir pool with time, and (2) the outflow hydrograph. Let:

- Q_i = average inflow in cu ft per sec for a chosen increment of time
- Q_0 = outflow in cu ft per sec at any instant of time
- Q_{0_1} = outflow in cu ft per sec at the beginning of the increment of time
- Q_{0_2} = outflow in cu ft per sec at the end of the increment of time
- $1/n$ = increment of time, in days, expressed as a fraction
- S = reservoir storage in cu ft per sec–days at any instant of time
- S_1 = reservoir storage in cu ft per sec–days at the beginning of the increment of time
- S_2 = reservoir storage in cu ft per sec–days at the end of the increment of time

The equation of continuity is

$$[Q_i - {}^1/_2\,(Q_{0_1} + Q_{0_2})]\,\frac{1}{n} = S_2 - S_1$$

Rearranging the terms,

$$(nS_2 + {}^1/_2Q_{0_2}) = (nS_1 - {}^1/_2Q_{0_1}) + Q_i \quad \ldots\ldots(1)$$

For any instant of time $(nS - {}^1/_2Q_0)$ and $(nS + {}^1/_2Q_0)$ are functions of pool elevation only, and for convenience

they will be denoted as $F(-)$ and $F(+)$, respectively. Table II shows the values of nS for this problem (for elevations from 350 to 370 ft), n being taken as 4 (that is, increment of time equals $^1/_4$ day), and values of $^1/_2Q_0$, where Q_0 is the outflow for ten gates in cubic feet per second. This table illustrates all the calculations necessary to construct the reservoir flood-routing chart shown in Fig. 2. By means of the holes on the index line C, the inner and outer pairs of concentric circles are drawn. On the inner pair of circles angular distances corresponding to values of $nS - {}^1/_2Q_0$ are laid off by means of the percentage protractor and the holes along index line C, and marked with the corresponding elevations.

TABLE II. VALUES OF nS FOR CHART SHOWN IN FIG. 2

Elev.	$nS\ 10^{-6}$	$\frac{Q_0}{2} 10^{-6}$	Elev.	$nS\ 10^{-6}$	$\frac{Q_0}{2} 10^{-6}$
350	2.352	0.020	361	3.340	0.064
351	2.428	0.024	362	3.435	0.068
352	2.516	0.028	363	3.530	0.073
353	2.616	0.031	364	3.630	0.078
354	2.688	0.035	365	3.730	0.082
355	2.775	0.040	366	3.825	0.086
356	2.865	0.043	367	3.925	0.091
357	2.955	0.046	368	4.020	0.096
358	3.050	0.050	369	4.115	0.101
359	3.145	0.055	370	4.210	0.106
360	3.240	0.060			

Similarly corresponding values of $nS + {}^1/_2Q_0$ are laid off on the outer pair of circles and marked with the corresponding elevations. The number of inner and outer concentric circles required is dependent upon the degree of accuracy desired and upon convenience in reading the percentage protractor.

The procedure to determine how the reservoir pool elevation changes during an increment of time, in accordance with Eq. 1, is as follows:

Index line A is set on a point on the inner circle at the elevation of the pool at the beginning of the increment of time. The average inflow into the reservoir during the increment of time is then laid off as an angular distance between index lines A and B by means of the percentage protractor. Index line B then points to the elevation of the pool at the end of the increment of time on the outer pair of circles. For example (Fig. 2), index line A is set on El. 351 on the inner circle, which is the elevation of the pool at the beginning of the increment of time. The average inflow for the increment of time is 95,000 cu ft per sec. Index line B then points to elevation 351.5, the elevation of the pool at the end of the increment of time. Since the elevation at the end of an increment of time is the elevation at the beginning of the next increment of time, the value of the elevation indicated by index B becomes the setting for index A for the next increment of time. The chart in Fig. 2 can now be used to route any inflow flood hydrograph through the reservoir with ten gates operating. Incidentally this chart could have initially been calibrated in terms of Q_0, or both Q_0 and the elevation could be marked on the same chart.

The foregoing simple example illustrates the application of the circular point-by-point computer to a typical reservoir problem. The advantages which the instrument offers in the solution of such problems, especially when they are of an extensive nature, are the ease and rapidity of obtaining answers, the consistency and accuracy of the results, the flexibility of changing the boundary conditions in the computations, and the securing of permanent working charts for the operation of the project.

As an illustration of the ease and rapidity of obtaining an answer, the problem of determining the spillway capacity required to pass a design flood without the reservoir level's exceeding a given elevation is an excellent example. Starting from scratch, the circular point-by-point computer chart may be constructed, the design flood routed through the reservoir and spillway for various numbers of gates operating and for various starting elevations of the pool, and the final answer of the number of gates required to limit the maximum pool elevation determined, all in a fraction of a day. The effect on the pool level or spillway outflow of opening the gates in advance of the flood, or of any other scheme of gate operation, is readily obtainable.

Attention should be directed to the small amount of numerical tabulations involved and to the elimination of cut-and-try processes. The consistency and accuracy of the results may be illustrated best by using the computer in the solution of a flood routing reservoir problem which lends itself to solution by means of formal integration. A comparison of the results obtained by the computer, for various values of the increment of time, with the results obtained from formal integration, indicate that the accuracy of the computer method is good if the increment of time is kept within about 10% of the flood duration time.

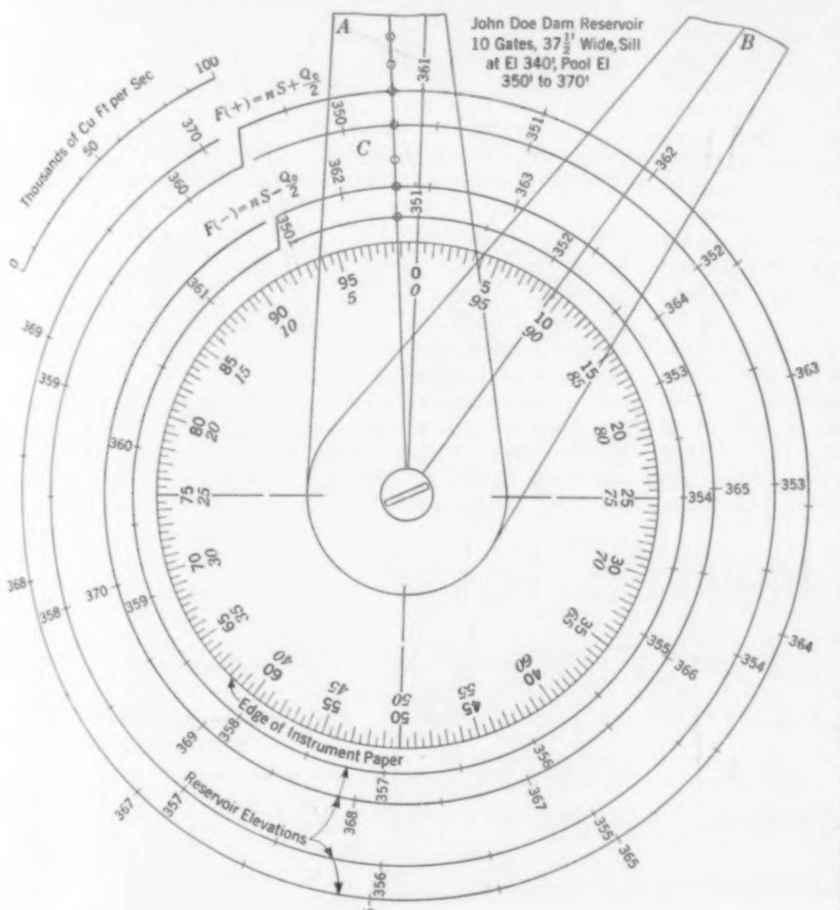

FIG. 2. COMPUTER WITH A FLOOD-ROUTING CHART FOR A PROJECT WITH TEN GATES

Engineers' Notebook

Ingenious Suggestions and Practical Data Useful in the Solution of a Variety of Engineering Problems

Connecticut Experiments with Novel Highway Marking

By GEORGE S. BEEBE

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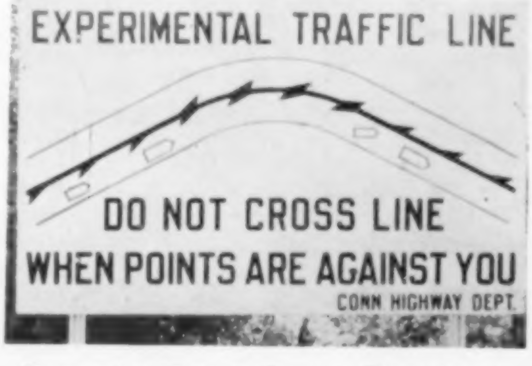
THROUGH a four-mile length of one of Connecticut's trunk-line highways a new and unique marking system has been put to test before the driving public. The location was chosen especially for its comparative difficulty, as the highway is of the familiar two-lane construction, through a village with its many intersecting roads, in particularly hilly country with the grades and curves that are characteristic of New England. Since any highway marking is solely for the guidance and protection of vehicle drivers, further use of the new system, as well as publicity for it, await the reaction of the public.

The fundamental purpose of the new system is to give character and flexibility to the marking not found in a simple painted guide line, and to convey to the driver an idea of the degree of danger he faces in passing other cars, where he is not certain as to what lies ahead. To accomplish this without confusion is the aim of the new system. The principle is simple—the driver is warned by signs not to cross any line which has the directional barbs turned toward, that is, against, him. Although the system is readily adaptable to any number of lanes or conditions, its use on an ordinary two-lane highway best illustrates its worth. First, with a simple curve the center line of the approach tangent is marked with a single solid white line with no barbs on either side up to a point where, with appropriate speed, there is no longer a clear sight line for passing a slower vehicle. Beginning at that point, and pointing back and to the right toward the approaching vehicle, short pointed barbs are attached to the center line. These are spaced an average of 25 to 30 ft apart. Continuing on the curve to a point where a vehicle coming in the opposite direction once again obtains a clear sight line, the barbs change character and assume a double or diamond shape, pointing both back and to the right and ahead and to the left, to indicate no passing in either direction. This continues on around the curve, and the procedure is reversed as the other tangent is approached. The degree of danger is indicated by the spacing of the barbs; closer spacing indicates greater danger. On tangents and flat curves without sharp grade changes, intersecting highways, or other grade crossings, the marking becomes a single center line without any barbs, indicating that no danger from passing exists—assuming, of course, a clear highway ahead.

While the most feared type of motor accident is a collision of two or more cars, a very important phase of prevention work is the reduction of mishaps to single vehicles. A definite advantage of the directional barb marking over other types lies in the extreme simplicity of the line and the fact that the sudden appearance of the barbs warns the motorist that a danger point is immediately ahead. He realizes not only that he is not to pass over the line but also that he is approaching a situation which demands closer attention and reduced speed. It has been proved that the barbed line is discernible from some distance and therefore gives ample warning to approaching traffic.

POINTS ON WHITE LINE DIRECT MOTORISTS
Foreground, Crossing Prohibited in Either Direction; Background, Crossing to Left Lane Permitted, but Crossing to Right Lane Prohibited

Comparing the new marking with other methods now in use, it should be said that but one operation is required to put the single line down on the roadway, and the use of only one color simplifies its application and makes it more visible at night or in fog. For applying this new type of line, apparatus has been devised consisting of concentric disks so arranged as to make the application almost automatic using a paint spray. Further trials with an asphalt base and vitreous aggregates are planned. Further, in support of this type of marking, it should be said that there is less for the fast-moving driver to see than in the case of a double or triple line. The result should be less confusion and a quicker reaction on the part of the driver. From the point of view of economy, the saving in paint will reach considerable proportions and the saving in the labor of application should be even greater.



DIRECTIONAL TRAFFIC SIGN AT ENTRANCE TO EXPERIMENTAL AREA

The originator of this type of marking and of the device for applying it is the writer's father, L. H. Beebe, M. Am. Soc. C.E., resident engineer of construction, State Highway Department, Norwich, Conn.

Nomograph for Computing Elevations of Stilling Basin Aprons

By Clarence Freeman

Tulsa, Okla.

Trial-and-error methods are normally used to determine the theoretical apron elevations for spillway or conduit stilling basins in which dissipation of energy is obtained by a hydraulic jump. This cumbersome procedure may be eliminated by the use of simple nomographs, which are suitable for preliminary or approximate design. Their construction is described here.

Table I. Computed Characteristics of Hydraulic Jump for Unit Energy Head

(1) $\frac{q}{H_a^{3/2}}$	(2) $\frac{d_1}{H_a}$	(3) $\frac{q}{(H_a - d_1)^{3/2}}$	(4) $\frac{d_2}{H_a - d_1}$	(5) $\frac{q}{(1.111H_a - d_1)^{3/2}}$	(6) $\frac{d_2}{1.111H_a - d_1}$	(7) $2\frac{V_1/2g}{d_1}$
0.080	0.195	0.111	0.242	0.091	0.213	198.0
0.198	0.300	0.337	0.429	0.271	0.370	78.0
0.390	0.411	0.863	0.699	0.665	0.586	38.0
0.579	0.491	1.595	0.966	1.187	0.791	24.7
0.761	0.552	2.54	1.233	1.822	0.987	18.0
1.11	0.642	5.18	1.795	3.46	1.370	11.3
1.44	0.706	9.03	2.40	5.59	1.744	8.00
1.73	0.750	13.84	3.00	7.96	2.08	6.00
2.02	0.780	19.55	3.55	10.60	2.36	4.66
2.26	0.797	24.7	3.93	12.83	2.54	3.73
2.49	0.800	27.8	4.00	14.36	2.57	3.00

Note: Exponential equations hold for values above dashed lines.

In Table I are shown unit characteristics of a hydraulic jump ($H_a = 1$). The nomenclature and equations used in their computation are as follows:

H_a = energy head available for the formation of a hydraulic jump

d_1 = depth of flow before a hydraulic jump

v_1 = velocity of flow before a hydraulic jump

$d_2 = -\frac{d_1}{2} + \sqrt{\frac{d_1^2}{4} + \frac{2V_1^2 d_1}{g}}$ = depth of flow after a hydraulic jump in a rectangular channel

$q = d_1\sqrt{2g\,(H_a - d_1)}$ = discharge per foot of width of rectangular stilling basin

Z = energy head minus depth after jump; or elevation of energy gradient before jump minus elevation of water surface after jump; or energy gradient elevation minus tailwater elevation

$\lambda = 2\frac{V_1/2g}{d_1}$ = kinetic flow factor

g = acceleration due to gravity

Columns 1 and 2 of the table may be computed by using the general methods described by Boris A. Bakhmeteff in *Hydraulics of Open Channels,* Chapter 18. For every value of $\frac{q}{H_a^{3/2}}$ there is a corresponding value of $\frac{q}{(H_a - d_2)^{3/2}}$, and since $H_a = 1$ in the table, Col. 3, $\frac{q}{(H_a - d_2)^{3/2}}$ was computed from Col. 1 by dividing tabulated values by $\left(1 - \frac{d_2}{H_a}\right)^{3/2}$. Similarly Col. 4 was developed by dividing values of $\frac{d_2}{H_a}$ by $\left(1 - \frac{d_2}{H_a}\right)$.

If it is desired to include a factor accounting for energy losses between the energy gradient elevation and the apron elevation, the table can still be entered with absolute values as before. However in this case the dividing parameter will be $\frac{1.0}{1.0 - \%\text{ of head lost}} - \frac{d_2}{H_a}$; by this means the table remains in terms of $H_a = 1$. Values in Cols. 5 and 6 are shown for an energy loss of 10% between the energy gradient elevation and the stilling-basin apron elevation. The kinetic flow factor appears in Col. 7.

By plotting the tabular values logarithmically, it will be found that the majority of values show a simple exponential relationship. Thus for almost the entire range of shock-type jumps (with kinetic flow factors greater than 3.0), a simple exponential equation applies. The resulting equations follow:

$\frac{q}{H_a^{3/2}}$ versus $\frac{d_2}{H_a}$ yields

$$d_2 = 0.630\,H_a^{0.303}q^{0.455} \qquad (1)$$

which holds for λ ranges of approximately 11.3 to 200.

$\frac{q}{(H_a - d_2)^{3/2}}$ versus $\frac{d_2}{(H_a - d_2)}$ yields

$$d_2 = 0.760Z^{0.223}q^{0.518} \qquad (2)$$

which holds for λ ranges of approximately 4.66 to 200.

$\frac{q}{(1.1\,H_a - d_2)^{3/2}}$ versus $\frac{d_2}{(1.1\,H_a - d_2)}$ yields

$$d_2 = 0.728Z^{0.220}q^{0.514} \qquad (3)$$

which holds for λ ranges of approximately 6.00 to 200.

Equations 2 and 3 hold over the entire range of hydraulic jumps met in usual practice and lend themselves

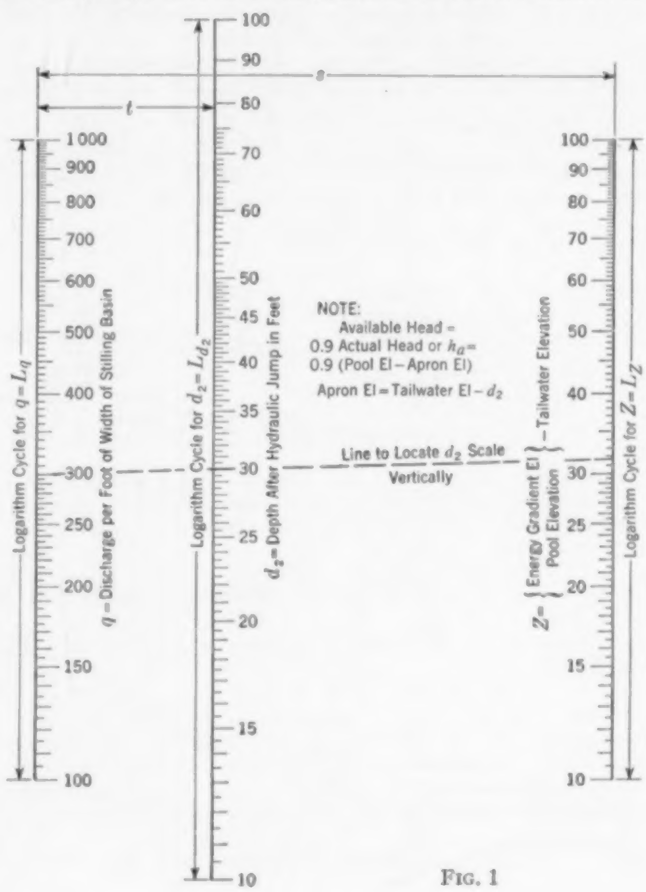


Fig. 1

conveniently to nomograph construction. The diagram, Fig. 1, illustrates the construction of a nomograph for Eq. 3, to fit a sheet of 8½ by 11-in., 1 cycle × 1 cycle logarithmic paper. This equation is of the form $d_2 = CZ^aq^b$. Proceeding in the usual manner, eliminate C by grouping it with d_2, $\frac{d_2}{C} = Z^aq^b$. Thus C merely fixes the vertical position of the d_2 scale. The q and Z scales are set by the logarithmic cycles available on the sheet.

Lateral location of the d_2 scale is computed by

$$\frac{l}{s} = \frac{L_q/a}{(L_q/a) + (L_Z/b)}$$

The size of the d_2 scale logarithmic cycle is

$$L_{d_2} = \frac{L_qL_Z}{aL_q + bL_Z}$$

Locate the d_2 scale vertically by solving for any value of d_2.

The nomograph is applicable to any design condition where the upstream elevation of the energy gradient, the tailwater elevation, and the unit discharge are known. By entering the nomograph with Z and q, d_2 results directly; the desired apron elevation results when d_2 is subtracted from the tailwater elevation.

Flow at High Velocity in a Curved Rectangular Flume

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AN opportunity of observing the behavior of water flowing at high velocity in a large curved flume is available at the La Tuque Plant of the St. Maurice Power Corporation, on the St. Maurice River in the Province of Quebec.

Eight to sixteen million 13-ft logs have to be passed each summer in a four-month season over a drop of 113 ft, and for this purpose a log chute 14 ft wide was designed, as shown in Fig. 1. The pondage is small and the inflow and power output are closely regulated; hence fluctuation in headrace levels will be small and gradual. The flow in the chute will therefore be controlled by appropriate changes in the stop-logs at the entrance, to which the logs are guided by floating booms. Water can be shut off by a sliding gate as well. There are also two small regulating sluice gates nearby, through which logs could be passed if necessary.

Under favorable conditions, with a downstream wind, the logs slide on the bottom of the chute, which is lined with steel rails, and need little more than enough water for lubrication. Logs are not damaged by sliding, but they may be broomed or split by hitting other logs idly floating near the exit of the chute, and for this reason care was taken to have them carried off by the tailrace flow. With an upstream wind more water must be used to create a draw at the entrance.

CALCULATIONS FOR THE DESIGN

From the differential equation of a particle sliding on a rough vertical curve, the probable velocity of the sliding logs alone was estimated to be 45 to 50 ft per sec, using a coefficient of friction of 0.25. Hydraulic calculations for water alone gave velocities of 44 to 72 ft per sec, depending on the flow, taking Manning's n at 0.009 and using W. G. Steward's method of calculation as quoted by F. C. Scobey (Technical Bulletin No. 393, U.S. Bureau of Agriculture, p. 91). The radial slope, which was obviously necessary, was found from the ordinary equation for superelevation of railway track which applies also to the slope of a liquid in rotation, namely $\tan\alpha = v^2/gr$. This gave a convenient value of 1:4 for a selected velocity of 56.2 ft per sec. Continuing the analogy, a transition was provided by gradually dropping the inner edge of the floor, as shown in Fig. 1, but the added complexity of varying the radius did not seem necessary. The general arrangement was about right, because at small flow a group of four logs is reported to stay straight and parallel, and in the middle of the width.

It was reassuring to find a little later, by accident and in a rather unusual volume, that experiments by R. T. Knapp and A. T. Ippen on a model of a very similar flume had shown satisfactory behavior (*Proceedings* of the Fifth International Congress for Applied Mechanics, John Wiley & Sons, Inc., 1939, p. 531). This paper suggested the idea of reporting the performance of the La Tuque chute as a flume rather than as a slide, after completion of the plant in the summer of 1940. A. H. Watier, of the Shawinigan Water and Power Company, happened to be visiting the plant at a time when this could be done, and he obtained the sections shown in Fig. 2, and at the same time commented on the fact

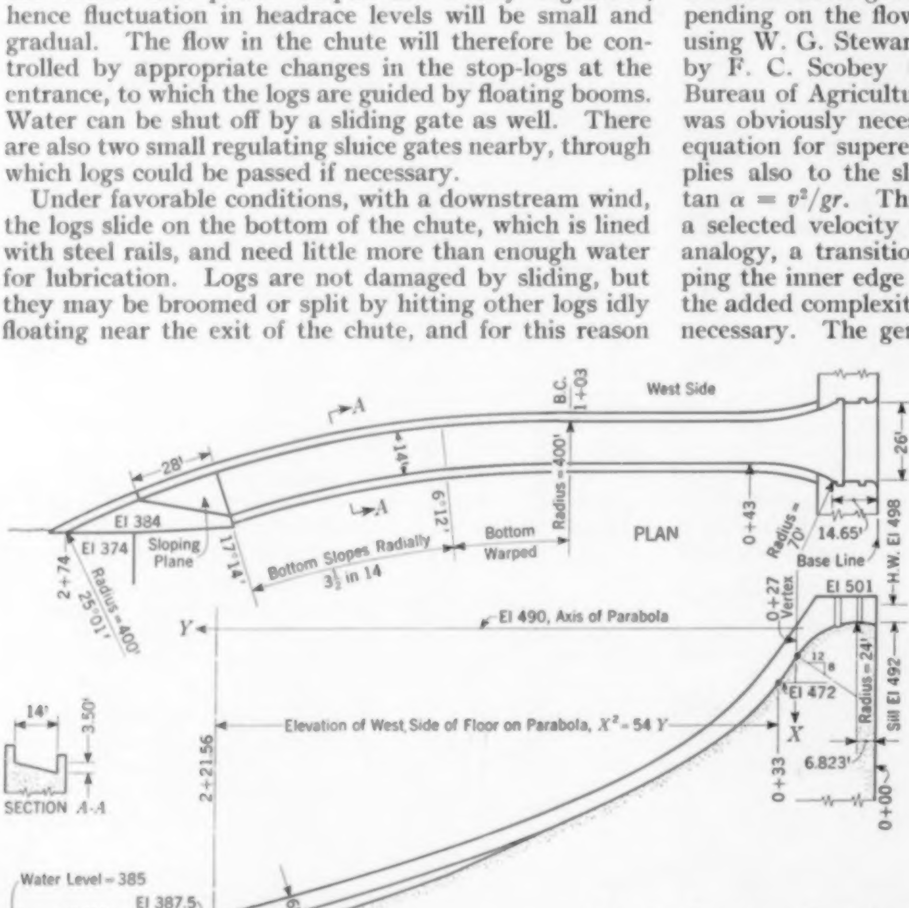


FIG. 1. PLAN AND ELEVATION OF CURVED RECTANGULAR FLUME AT LA TUQUE PLANT OF ST. MAURICE POWER CORPORATION

that the water surface was plane, and the depth the same, all around the curve.

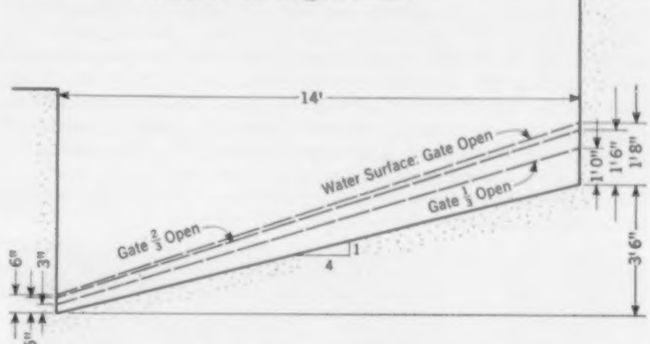
At full gate, flow was estimated from entrance dimensions as 728 cu ft per sec. Using the observed transverse slope of the water surface and the equation previously mentioned, the mean velocity in the section was estimated to be $\sqrt{32.2 \times 393 \times 56/168} = 65$ ft per sec, instead of 71 as expected. Another estimate of velocity can be obtained by dividing the sectional area of 15.17 sq ft into the flow, to give 48 ft per sec. This of course is too low because no allowance has been made for the air which is entrained in the section at such high velocities. The ratio of these velocities shows an expansion of 35% in the water prism from this cause, which is consistent with the 30% or more quoted by Steward (loc. cit., p. 90). Taking n at 0.0105 would make the expected velocity agree with the estimated velocity. Whether that is correct cannot be stated without observations at other flows. Unfortunately there are no data for estimating flows at the part gates.

CURVATURE MAY BE USED WITH CONFIDENCE

The difficult experimental work of measuring these high velocities and the proportion of air entrained cannot be undertaken at present, but the rough measurements and the model experiments mentioned do show that curvature in high-velocity flumes of this type may be used with confidence; and the sections for partial gate openings show that some considerable departure from the design flow is possible without trouble.

A slight improvement in the design of the side walls, near the top, could be made. At present these wall sur-

Fig. 2. Observed Water Surfaces in the Curved Flume of La Tuque Plant



faces are vertical cylinders, so that some sections at right angles to the axis of the stream appear as trapeziums, narrower on top. This is of use in throwing the logs away from the sides, but it makes a central wave from which spray may be blown. The condition is not serious enough to require alteration, but it will be corrected in future designs.

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

The Engineering Method and Economics

Dear Sir: I have read with great interest the article by Bernard L. Weiner on "Engineers and World Economy," in the December issue, and the subsequent discussion.

I fully agree with Mr. Weiner that the introduction of engineering thinking and methods into the field of economics will eliminate breakdowns of the world economy. Financial depressions, far from being "a product of the emotions, and not of the intellect," are directly connected with our antiquated monetary system. Mr. Weiner quite correctly states that instead of "adjusting the money tool" to our capacity to produce and consume, "the cart has been put before the horse and money permitted to determine these needs."

I wish to point out that a complete analysis of the "mystery surrounding the money factor" and the causes of the periodic breakdowns of the world economic system with their inevitable wars is outlined in a book by Silvio Gesell entitled *The Natural Economic Order*. In this work there is also outlined a scientific method for the elimination of these breakdowns, which engineers might well scrutinize and apply. Briefly, the method consists of the following three proposals:

1. Stabilization of the price level, not through the setting of price ceilings and other restrictions, but by varying the amount of money in circulation (check-book money and paper currency). Such a policy was used successfully in Norway, Sweden, and England in the early thirties and in part in our own country in the middle twenties.

2. Government control of the issue of money, and not private control, as it is today with our Federal Reserve System.

3. A non-hoardable monetary system, which will prevent the withdrawing of large sums of money from circulation at will by any individuals or groups, and will also stabilize the rate of "turnover of money," a factor which has puzzled and continues to puzzle modern economists. The fact that the money tool of today can be hoarded or withdrawn from circulation at will by anyone, introduces the "emotional element" in financial depressions mentioned in the subsequent discussion. With a non-hoardable monetary system the emotional element becomes insignificant and is finally eliminated.

I consider articles such as Mr. Weiner's a great contribution to the solution of the world economic problem and fully agree with him that the problem can be solved correctly by engineers and scientists and not by politicians and dictators and, may I state, even bankers.

E. J. Critzas, Assoc. M. Am. Soc. C.E.
Construction Engineer, Borsari Tank Corporation of New York
St. Louis, Mo.

Rubble Masonry Construction

To the Editor: The article by L. M. Winsor on "Rubble Masonry for Road Culverts and Retaining Walls," in the January issue, is particularly pertinent at this time when construction materials are of utmost importance. The writer would be grateful for more specific and detailed information on the subject.

Present-day engineering requires information relative to the strength of materials prior to their extensive use in construction. It is usually uneconomical to base a design on judgment alone even though it is backed by years of experience. The writer knows of cases in which rubble masonry walls and dams have failed. The reasons for failure are varied and include poor design and construction and inadequate foundations. Structural failure tends to give a "black eye" not only to the constructor and engineer but also to the material involved. The tendency to structural failure is accentuated when the design is based, to a large extent, on judgment. Excessive costs follow. The inevitable result is that extreme caution is used in future design and construction of similar structures.

Ordinary rubble construction is frowned upon by some engineers because, in many cases, the cost is as great as or greater than that of concrete. One of the main reasons for this is the high degree of skill required in good rubble construction. Experienced stone masons are hard to find, and their wages are high. The type of construction Mr. Winsor describes should reduce the cost appreciably.

Data on the strength of the type of construction Mr. Winsor proposes would be of value to engineers in designing various structures. If such data are not available for this type of material, it seems to the writer that it would be worth while for some engineering research group to make tests to obtain this information. Cost data on this type of rubble construction would also be useful to any organization contemplating its use. Costs expressed in man days or hours per cubic yard, plus units of materials per cubic yard coupled with general strength figures at least, would go a long way toward giving a basis for comparing this type of construction with more standard methods.

Today the engineering profession is faced with a challenge worthy of supreme effort. Maximum conservation of energy, steel, lumber, cement, and so on is essential to the preservation of the social order we are used to and prefer.

ROGER E. AMIDON, Assoc. M. Am. Soc. C.E.

Altadena, Calif.

Progress in Analysis of Weather Data

DEAR SIR: Interest in the cyclic nature of meteorological data springs up from time to time, and with each revival there is undoubtedly some forward progress. Unfortunately, in many instances the aspects of the problem which seem important at the time prove to be false leads in the light of subsequent developments. However, Mr. Kennedy's contribution, in the January issue, is noteworthy.

In the past much effort has been expended on cyclic analysis without sufficient consideration of the very serious inherent limitations. These limitations are so intricate that no discussion of them should be attempted within the space of such a letter. They are, however, covered in brief in an article in *The Baltimore Engineer* of November 1941 (subsequently reprinted in *The American Engineer* for January 1942).

There have been many disappointments in the past, and I fear that if we are looking for some magic key by which the mysteries of the future weather may be unlocked, the prospects are not bright. Earlier attempts have been frustrated not only by the failure of mathematics to serve as an adequate tool for this specific purpose, but also by the imperfect nature of the basic data. We cannot find long records sufficiently free from irregularities in systematic errors to avoid false and misleading conclusions.

It is all too true that the end depends upon the beginning, and we must first make sure of our foundations before building upon them. Anything that we do to improve the quality and reliability of meteorological records, or to isolate and make allowance for the systematic errors in the past is in itself a worthy accomplishment. Consequently no matter how badly we may fail in the main purpose, the by-product alone may well justify the effort expended.

Once the foundation is laid we must still be mindful of the fact that even purely accidental arrangements of data, when subject to analytical treatment, can present apparently convincing evidence of cyclic variations. One means of guarding against coming to false conclusions is to look to contemporary data and see if the same cycles are manifested in them.

The fact that purely accidental sequences exhibit the same characteristics in this respect as the true cyclics, makes it seem logical to depart from this method, as Mr. Kennedy has, and to examine the other respects in which the two may be differentiated. Although it must be recognized that in a short series of data very wide departures from the theory of chance may be expected, nevertheless as the length is increased the probability of abnormal behavior is tremendously decreased. There are undoubtedly many ways of accomplishing Mr. Kennedy's purpose but the dominant idea is excellent, for it offers at least one means of escape from the danger of deceptive results that always threaten to cast doubt on the fruits of years of work devoted to the established methods of cyclic analysis.

Standing as we do on the threshold of a fuller knowledge of the nature of meteorological data, it is impossible to do more than surmise whether these data will prove to be purely accidental or not. We must proceed with an open mind, weighing the evidence carefully and without prejudice. On the other hand, it is not too early to consider the consequences of definitely determining that their nature is not accidental but governed by certain regular, or irregular, swings which may be related to other similar trends in other types of observation. Such a discovery would greatly alter our ideas concerning the establishing of normal values, and reduce decidedly the length of time believed to be necessary to derive a satisfactory average. It would have an important bearing upon the adjustment of earnings from projects dependent upon climatic variations. To carry the idea further, it will be appreciated that if the relations between variations in one type of data could be related to the corresponding variations in other types, this fact in itself might give an important clue to the fundamental nature of climatic variations. Such knowledge would certainly be of greater scientific value than the discovery of a combination of harmonic components which, when properly synthesized, would grind out the future weather perhaps even years in advance—a dream which at the present time has only the remotest chance of fulfillment.

CARROLL F. MERRIAM

Baltimore, Md.

Universal Adoption of Metric System Favored by South American Engineers

TO THE EDITOR: I was pleased to read the comments on the metric system made by S. U. Benscoter in the December issue of CIVIL ENGINEERING. One of the most surprising things about the United States—to us the Spanish-speaking engineers—is that the American people, so wise, progressive, and practical in many aspects of life, are still using a system that looks so "crude and clumsy" beside the "logical and readily usable" metric system. We are using today in our studies and practice more American books and methods than those of any other nation in the world, and our average engineer is becoming more and more acquainted with the English language in an effort to make available to himself all the technical papers published in the United States, in spite of the tiresome difficulty of the "always-must-be-at-hand" conversion factors.

It is easy to realize the strenuous task of designing a steel structure using American sections, or of writing specifications, in the English system, for materials to be used in projects designed entirely in metric units!

I am very convinced that the adoption by the United States of the metric system will prove to be much more valuable than the amount of time, money, and effort that no doubt will be necessary to accomplish the shift. As Mr. Benscoter says, it would be interesting to have the comments of members of the Society on the subject. Above all, it would be interesting to see the comments of those American engineers who have had to submit reports and plans in metric units, when they were working for countries south of the Rio Grande!

GUSTAVO PEREZ GUERRA, Jun. Am. Soc. C.E.
Assistant Engineer, Water Works Division
Ministery of Public Works of Venezuela

Caracas, Venezuela

Error in Formula Corrected

[*Editor's Note:* Attention is called to an error appearing in the article on "Foundations for Buildings" by Jacob Feld in the January issue of CIVIL ENGINEERING. The correct form of the Boussinesq formula (page 15) should be: "The vertical stress at any point in the mass equals $\frac{3Pz^3}{2\pi R^5}$."]

SOCIETY AFFAIRS

Official and Semi-Official

Society's Spring Meeting at Roanoke, Va.

New Type of Quarterly Gathering Adapted to War Emergency to Convene at Hotel Roanoke on April 19–23, 1942

In February the decision was reached to hold the Spring Meeting of the Society at the Hotel Roanoke at Roanoke, Va., during the week of April 19–23, 1942. This is the quarterly meeting of the Society, originally planned to be held in New Orleans under the auspices of the Louisiana Section. In view of this change in plan, members may be interested in the background of Society policy that made revision of scheduled meetings necessary.

Now that our country is at war, the Society has pledged itself to support the Government still more strongly in its war effort, and a resolution to that effect was adopted at the January meeting of the Society and sent to the President of the United States. Many functions of the Society are to be subordinated or eliminated in an effort to direct our thinking along the lines of our country's struggle. Rather than eliminate meetings of the Society or meetings of Local Sections, the Board of Direction has stated that the meetings should assume more importance than ever before and has suggested that the technical content of the programs of meetings should be such that the papers and discussions will be of immediate and practical assistance to civil engineers engaged in the war effort in improving their abilities to serve the Government.

The Board has directed also that the meetings during 1942 shall be held at points where busy Local Section members will not be burdened with the many details of arrangements or with elaborate entertainment, the expense of which could be devoted to Defense Bonds, for example, with greater effectiveness. The meetings are to be streamlined in every respect. The Secretary's staff and the Technical Divisions are arranging the program details.

Technical Program Outlined

In line with this purpose, the Roanoke Meeting will take the place of the former New Orleans plan. It is the hope of the Board and of the members of the Louisiana Section that an early opportunity will present itself to hold a meeting of the Society with the Louisiana members. A tentative outline of the program of the Spring Meeting at Hotel Roanoke is as follows:

Sunday, April 19

Meetings of Committees of the Board of Direction

Monday, April 20

Meeting of the Board of Direction

Tuesday, April 21

Local Sections Conference, sponsored by Committee on Local Sections

Meeting of Technical Procedure Committee

Wednesday, April 22

Registration and Opening Session of the Society's Spring Meeting

Morning

General Session—Society's National Committee on Civilian Protection in War Time, with the Structural and Power Divisions cooperating

Afternoon

General Session, sponsored by Highway Division

Student Chapter Conference, sponsored by Committee on Student Chapters

Evening

Formal Dinner at Hotel Roanoke

Thursday, April 23

Morning

Simultaneous Sessions: Soil Mechanics and Foundations, Structural, and Surveying and Mapping Divisions

Afternoon

Simultaneous Sessions: Construction, Engineering Economics, and Sanitary Engineering Divisions

Roanoke, a city of 70,000 people, is located on the Norfolk and Western Railroad in western Virginia with good highway and railroad connections from all points. It is the headquarters of the railroad. It is also a division point, and the railroad's large shops are located here. There are also structural and bridge steel fabrication plants in Roanoke.

Hotel Roanoke, Headquarters for the Spring Meeting

Adequate Hotel Facilities

Roanoke Hotel occupies a ten-acre plot adjacent to the railroad station, five minutes' walk to the center of the city. The meeting rooms in the hotel and many of the 325 bedrooms are air-conditioned. Not only will all the facilities of the Hotel Roanoke be placed at the disposal of the Society for Tuesday, Wednesday, and Thursday of the meeting week, but there are two other hotels in Roanoke which can handle the overflow, the Patrick Henry and the Ponce de Leon. No other conventions are being scheduled for Roanoke during our meeting period.

The rates at each of the hotels are reasonable, and special rates have been provided by the hotels for students who are willing to put up with limited accommodations.

Ladies Provided For

The social features of the meeting will be those that can be afforded by the regular facilities of the Roanoke Hotel—which is within forty miles of the Natural Bridge. A bus trip for the ladies, on Thursday, has been arranged to Lexington, Va., for a visit to the campus of Washington and Lee University, and to the adjoining grounds of the Virginia Military Institute, to attend a military review of the cadets of the Institute. The return trip to Roanoke will be made by way of the Natural Bridge, where a picnic supper will be held in the twilight. The ladies will be joined by the men, who will be taken to the Natural Bridge from the hotel at the close of the sessions on Thursday.

Local Sections Conference

The Sections to be represented at the Spring Conference of Local Sections are those in the Southern Meeting Region, as follows: Alabama Section, Florida Section, Georgia Section, Kentucky Section, Louisiana Section, Miami Section, Mid-South Section,

NATURAL BRIDGE OF VIRGINIA, GOAL OF A ROANOKE MEETING TRIP

Nashville Section, North Carolina Section, Oklahoma Section, Panama Section, Puerto Rico Section, South Carolina Section, Tennessee Valley Section, Texas Section, Virginia Section, and West Virginia Section. While the Local Sections Conference is open to all members of the Society who may wish to attend, it is expected that a representative from each of the Sections mentioned will be prepared to participate in the program. The Section's representative is to be an officer, or a member of the Local Section's board of directors. To many, the Local Section conferences have proved to be a vital part of the Society's meetings.

STUDENT CHAPTER CONFERENCE

The Student Chapters Conference is to be guided by the Society's Committee on Student Chapters. Details of arrangements and the program of speakers all are handled by student officers. Special invitation has been issued to the Regional Conferences of Student Chapters in the southeastern part of the United States, to make plans for meetings of their respective conferences at the time of the Spring Meeting in Roanoke. These include the Carolina Conference, the Virginia Conference, the Maryland–District of Columbia Conference, and the Southeastern Conference. Aside from the Student Conference and the technical program of the Society, there will be numerous opportunities for engineering students to become familiar with the activities of the profession and with opportunities for service to the Government.

The complete program of the meeting will appear in the April issue. It is anticipated that this advance notice will enable many members to make arrangements to attend the Spring Meeting in Roanoke. In this way will the Society through its national and local officers be enabled to keep aware of the unfolding and expanding war activities of the Government and take such steps from day to day as are deemed practicable to support them.

Meeting of the Outgoing Board of Direction—Secretary's Abstract

ON JANUARY 19–20, 1942, the outgoing Board of Direction met at Society Headquarters with the following members present: President Frederick H. Fowler in the chair; George T. Seabury, Secretary; Past-Presidents Riggs and Hogan; Vice-Presidents Jacobs, Lucas, Burdick, and Stevens; and Directors Blair, Bres, Brooks, Carey, Cunningham, Dunnells, Goodrich, Howard, Hudson, Hyde, Leeds, Lewis, Massey, Polk, Requardt, Sawin, White, and Wiley.

Also present during part or all of the sessions, by invitation, were the following members of the incoming Board as observers: Messrs. Black, Spofford, Stanton, Boughton, Burpee, Lilly, Rawn, Dickinson, and McNew.

Approval of Minutes

Minutes of the Board meeting of October 13–14, 1941 were approved; also of the Executive Committee meetings of October 12 and December 15, 1941. Where approved, actions and recommendations of that committee were adopted as actions of the Board and are so reported herein.

Annual Report for 1941

The Annual Report of the Board was presented, discussed, and approved. (Excerpts were given in the February number, pages 108 and 109; the full report will appear in the 1942 Yearbook to be published as Part 2 of the April 1942 PROCEEDINGS.

By-Laws Amended—"Election of Members"

In response to recommendation of the Committee on Professional Conduct, and following Constitutional procedure previously initiated, Article I, Section 10 of the By-Laws, relating to "Election of Members," was amended to provide for new members to subscribe to the Code of Ethics, and for the initiation of expulsion procedure for violation of the code. Details of the amendment will be found on another page.

Solidarity with Other National Engineering Bodies and Individuals

Communications of professional support and encouragement were received from Jose Garcia Montes, president of Socieded Cubana de Ingenieros; from Jorge L. Echarte, president of Colegio Nacional de Ingenieros Civiles de Cuba; from Professor Miguel Villa, M. Am. Soc. C.E., University of Havana, Cuba; and from L. Austin Wright, secretary, on behalf of the Council of the Engineering Institute of Canada. All indicated professional solidarity and sympathy with the Society and with American ideals. In reply, the Board adopted suitable resolutions, replying individually, reciprocating and emphasizing this unity.

New Mexico Section Offers Services

Official communication was received from the New Mexico Section offering assistance in efforts to secure engineers for national defense. Reply was drafted and adopted and ordered sent to all Local Sections. (See item on another page for details.)

Amendments to Local Section Constitutions

Approval was given to amendments, in regular form, to the Constitutions of the Connecticut, Mid-South, and Texas Local Sections.

Fort Belvoir Section Abandoned

A proposal for the establishment of a new Local Section of the Society at Fort Belvoir, Va., was reviewed. Due to the war, efforts in this direction had been dropped; the Board approved.

Engineers and Students in Military and Industrial Work

In connection with recommendations of the Committee on Engineering Education, the Board took action approving, among other things, of a procedure which it is hoped will ensure the best use of engineers and students in military and industrial work.

Also having in mind the worthy engineering student who is facing difficulty in financing himself in the new continuous engineering courses, the Board approved in principle the allocation to the Bureau of Education of such Federal funds as may be deemed proper to be expended by the Commissioner of Education to assist such students in these fields who have had, and maintain, satisfactory academic records to the end that they may complete their education in the shortest possible time.

Local Section Appropriation

Upon suggestion of the Committee on Local Sections, a new interpretation regarding technical meetings of Local Sections was adopted as follows:

"In order to qualify for full financial support from the Society, each Local Section is required to hold the equivalent of five technical meetings during the year. Meetings of Junior Forums, Sub-Sections, and each session (morning, afternoon, and evening) of all-day or two-day meetings of a Section will be considered as technical meetings when the subjects presented comply with the . . . definition."

Renewed Support to the President of the United States

The Board adopted a draft of a communication to the President of the United States, pledging continued efforts in the national defense; and recommended same for adoption by the Society at the Business Meeting at the time of the Annual Meeting. The wording of this communication, as adopted by the Society and transmitted to the President, is given in a separate item on another page.

Budget

A proposed budget of income and expenditures for 1942 was presented and discussed. As revised, this was approved for recommendation to the incoming Board.

Committee on Employment Conditions

The Board authorized the establishment of a committee, to address itself to the problems of employment conditions, making provision also for staff assistance.

Remission of Dues

Automatic remission of dues, upon receipt of satisfactory application, was authorized for all members in the armed services holding commissions of which base pay is equal to or less than that of a Captain in the Army.

Districts and Zones

Boundaries of Districts and Zones, for purposes of the election of officers, were fixed for 1942 as unchanged from those of 1941, as noted in a separate item elsewhere in these pages.

Committee Reports and Other Matters

Board committees, other than those mentioned, submitted reports. In addition, miscellaneous matters were presented. In all cases appropriate action was taken.

Adjournment

The 1941 Board of Direction adjourned to meet in its new 1942 membership, as in incoming Board, on January 22.

Meeting of the Incoming Board of Direction—Secretary's Abstract

THE INCOMING Board of Direction met at Society Headquarters on January 22, 1942, with President E. B. Black in the chair; and present George T. Seabury, secretary; Past-Presidents Hogan and Fowler; Vice-Presidents Burdick, Stevens, Spofford, and Stanton; and Directors Blair, Boughton, Burpee, Carey, Cunningham, Dickinson, Dunnells, Goodrich, Howard, Hyde, Lilly, McNew, Massey, Rawn, Requardt, White, and Wiley.

Society Meetings for 1942

In consideration of war conditions it was deemed advisable to discontinue plans, whereby burdens of a financial or administrative nature might be placed upon Local Sections acting as hosts for the scheduled Society meetings in New Orleans, Spokane, and Atlanta during 1942. Accordingly these meetings were canceled and in their place it was voted that three meetings be held at suitable cities or resorts to be selected, arrangements therefor to be made by the staff. Announcement of this change was given in the February issue, page 120. Roanoke Hotel, at Roanoke, Va., has been selected for the place of the Spring Meeting, April 19–23, 1942 (see page 161).

Budget for 1942

With changes due to the new plan for meetings, and with provisions for later adjustment as required, the budget for 1942 was adopted.

Committee Appointments

Upon designation by the President, Board and Society committees were confirmed as follows:

EXECUTIVE COMMITTEE: E. B. Black, *Chairman;* Ernest P. Goodrich, *Vice-Chairman;* Charles B. Burdick, Frederick H. Fowler, John P. Hogan, and Charles H. Stevens.

COMMITTEE ON HONORARY MEMBERSHIP: E. B. Black, *Chairman;* Charles B. Burdick, Frederick H. Fowler, John P. Hogan, Charles M. Spofford, Thomas E. Stanton, and Charles H. Stevens.

COMMITTEE ON DISTRICTS AND ZONES: Ernest E. Howard, *Chairman;* John W. Cowper, Charles G. Hyde, Scott B. Lilly, and George B. Massey.

COMMITTEE ON PROFESSIONAL CONDUCT: Charles M. Spofford, *Chairman;* Clarence M. Blair, V. T. Boughton, William N. Carey, A. M. Rawn, and Gustav J. Requardt.

COMMITTEE ON PUBLICATIONS: Clifford G. Dunnells, *Chairman;* George W. Burpee, Ernest E. Howard, Lazarus White, and Ralph B. Wiley.

COMMITTEE ON MEMBERSHIP QUALIFICATIONS: Charles G. Hyde, *Chairman;* Clarence M. Blair, John W. Cunningham, William D. Dickinson, Scott B. Lilly, and George B. Massey.

COMMITTEE ON SOCIETY RELATIONS: Charles H. Stevens, *Chairman;* George W. Burpee, and John W. Cowper.

COMMITTEE ON DIVISION ACTIVITIES: Charles B. Burdick, *Chairman;* William N. Carey, Clifford G. Dunnells, J. T. L. McNew, and Charles M. Spofford.

COMMITTEE ON LOCAL SECTIONS: William M. Spann, *Chairman*, term ending January 1943; James A. Higgs, Jr., term ending January 1944; Francis H. Kingsbury, term ending January 1945; Fred H. Rhodes, Jr., term ending January 1946; and J. T. L. McNew, *Contact Member*.

COMMITTEE ON JUNIORS: Frank V. Ragsdale, *Chairman*, term ending January 1944; Oliver C. Reedy, term ending January 1943; Charles A. Mockmore, term ending January 1945; John H. Gardiner, term ending January 1946; and William D. Dickinson, *Contact Member*.

COMMITTEE ON STUDENT CHAPTERS: Edgar M. Hastings, *Chairman*, term ending January 1943; Clarence L. Eckel, term ending January 1944; Frank W. Stubbs, Jr., term ending January 1945; Ben S. Morrow, term ending January 1946; and Charles G. Hyde, *Contact Member*.

COMMITTEE ON ENGINEERING EDUCATION: Louis S. LeTellier, *Chairman*, term ending January 1943; James A. Anderson, term ending January 1944; Nathan W. Dougherty, term ending January 1945; Ivan C. Crawford term ending January 1946; William E. Baldry, term ending January 1945; Conde B. McCullough term ending January 1946; and Ralph B. Wiley, *Contact Member*.

COMMITTEE ON REGISTRATION OF ENGINEERS: Lewis M. Martin, *Chairman*, term ending January 1943; T. Keith Legare, term ending January 1944; H. M. Jones, term ending January 1945; Enoch R. Needles, term ending January 1946; and Armour C. Polk, *Contact Member*.

COMMITTEE ON FEES: Louis R. Howson, *Chairman*, term ending January 1944; H. D. Mendenhall, term ending January 1943; Edward N. Noyes, term ending January 1945; Clarence McDonough, term ending January 1946; L. H. Nishkian, term ending January 1947; and Clarence M. Blair, *Contact Member*.

COMMITTEE ON SALARIES: Thomas E. Stanton, *Chairman;* Charles D. Avery, Arthur Richards, Andrew P. Rollins, and Charles S. Shaughnessy.

COMMITTEE ON PROFESSIONAL OBJECTIVES: Clifford G. Dunnells, *Chairman*, term ending January 1943; A. M. Rawn, term ending January 1943; Gustav J. Requardt, term ending January 1944; N. E. Lant, term ending January 1944; Paul L. Brockway, term ending January 1944; Glenn L. Parker, term ending January 1945; and Thomas R. Agg, term ending January 1945.

COMMITTEE ON TECHNICAL PROCEDURE: C. B. Burdick, *Chairman;* William N. Carey, Clifford G. Dunnells, J. T. L. McNew, Charles M. Spofford (all members of the Committee on Division Activities), and Harland Bartholomew, Chairman, City Planning Division; Harry O. Locher, Chairman, Construction Division; J. H. Porter, Chairman, Engineering Economics Division; C. E. Myers, Chairman, Highway Division; Fred C. Scobey, Chairman, Hydraulics Division; S. T. Harding, Chairman, Irrigation Division; William P. Creager, Chairman, Power Division; L. H. Enslow, Chairman, Sanitary Engineering Division; Carlton S. Proctor, Chairman, Soil Mechanics and Foundations Division; Glenn B. Woodruff, Chairman, Structural Division; William N. Brown, Chairman, Surveying and Mapping Division; and W. G. Atwood, Chairman, Waterways Division.

MEETING COMMITTEES:

Annual Meeting: C. M. Spofford, *Chairman;* C. M. Blair, Van Tuyl Boughton, George W. Burpee, E. P. Goodrich, and Lazarus White.

Spring Meeting: C. H. Stevens, *Chairman;* C. G. Dunnells, Scot B. Lilly, Gustav J. Requardt, and A. C. Polk.

Annual (Summer) Convention: Thomas E. Stanton, *Chairman;* John W. Cunningham, Charles G. Hyde, John T. L. McNew, and A. M. Rawn.

Fall Meeting: Charles B. Burdick, *Chairman;* William N. Carey, John W. Cowper, William D. Dickinson, Ernest E. Howard, George B. Massey, and Ralph B. Wiley.

COMMITTEES ADVISORY TO THE BOARD:

Committee on Post-War Conditions: Enoch R. Needles, *Chairman;* Harrison P. Eddy, Jr., Norman W. Funk, S. A. Greeley, E. L. Macdonald, E. B. Whitman, and A. C. Polk, *Contact Member.*

Committee on Employment Conditions: Charles B. Burdick, *Chairman;* R. B. Brooks, E. Lawrence Chandler, Ashley G. Classen, and Herman Stabler.

Adjournment

The Board adjourned to meet at the call of the President.

Board Advises Local Sections Re War Effort

A COMMUNICATION, adopted by the Board at its meeting on January 20, has been forwarded to the officers of all Local Sections, emphasizing not only what the Society has done to help in the national emergency but stressing also the relation of Local Section activities to the national effort. This action was taken in response to an inquiry from the New Mexico Section, but the implications were so broad that the reply was deemed of interest and importance to all the Sections. This letter was as follows:

The New Mexico Section of the Society has written to the Board of Direction offering its services in any National Defense and War Program sponsored by the Society and has asked what action the Society is taking regarding such a program. The subject matter of the New Mexico Section's letter is so appropriate that the Board of Direction believes its answer should be directed not only to that Section but to all Sections.

Some of the actions sponsored by the Society, before war was declared, may be listed as follows:

The Society issued questionnaires in June 1940, to determine the services which engineering firms or individual consultants in all branches of engineering were prepared to render the Government. The data thus gathered from 3,225 responses were transmitted to the Quartermaster Corps of the Army, the Corps of Engineers of the Army, and to the Civil Engineer Corps of the Navy.

Designated members of the Society have been in frequent collaboration with various Government boards.

Official advisers have been appointed to several committees established by the Government.

Six official representatives have been named to the Engineers Defense Board, formed to advise the Office of Production Management with respect to selecting substitutes, eliminating waste, simplifying specifications and standards, and improving design techniques with respect to strategic metals.

The Society at its Annual Convention at San Diego, in formal session, passed a resolution pledging to the President of the United States complete support of his efforts in behalf of National Defense.

An office has been opened in Washington, and an Assistant to the Secretary secured to be resident in Washington, to keep the Society advised, among other things, as to how it can best assist the Government war activities.

Weekly, if not oftener, some members of the headquarters staff have been engaged in conference with authorized Government officials, or in the performance of work requested by them in connection with some phase of the defense or war effort.

A National Committee, authorized in July 1940, and 62 local committees, to study matters related to Civilian Defense, have been established. Their efforts have been continuous to date, and will be intensified in this coming year.

Since the declaration of war the Technical Divisions of the Society have been directed to address their efforts to the preparation and presentation at meetings of papers related especially to matters contributory to the war effort and to civilian defense.

The Board realizes the importance of the allocation of recent engineering graduates of selective service age so that the supply of engineering talent in industry and in the Navy and in the Army will be properly distributed; and steps have been taken to bring this about.

Attention is called to the engagement of Mr. Fowler, when President of the Society, in an important post in Washington with the War Department. As such, Mr. Fowler, a spokesman of excellent qualifications, has been in position to point out the proper employment of the Society and its members, where their efforts may be best used.

Now that the country is at war, the Society should pledge itself more strongly to support the Government in its war effort, and a new resolution to that effect has been adopted by the Board of Direction and sent to the President of the United States.

The Board's message to the Local Sections may be summarized as follows:

"The American Society of Civil Engineers, through its national and local officers, should keep aware of the unfolding and expanding war activities of the Government and take such steps, from day to day, as deemed practicable, to support the Government in its efforts.

"It is intended that the Local Sections will be kept advised of information obtained by the Society's representative at Washington and the Local Sections are requested to inform the Secretary of the Society promptly of difficulties encountered in any part of the War Program, wherein it appears that the Society can be of help.

"The Local Sections are hereby not only authorized, but urged, to adapt their activities this year to assist in the war effort, and in civilian defense, in cooperation with authorized Federal, state, or local authorities."

Society Business Meeting to Be Held March 18

A REGULAR MEETING of the Society will be held in the Engineering Societies Building, 33 West 39th Street, New York, N.Y., on the evening of March 18, 1942, at 8 p.m. The sole purpose of the meeting is to canvass the ballots on the proposed amendment to the Constitution in regard to the age limit and dues of Juniors.

This announcement is made in compliance with the requirement of the Constitution that Corporate Members shall receive official notice 15 days in advance of the meeting. No other business will be considered. If the canvass shows the amendment to have an affirmative vote of two-thirds of all ballots cast, it will become effective on April 17, 1942.

Question Forum on Engineering Economics

A SERIES of questions on current problems was inaugurated in the January 1942 issue by the Executive Committee of the Engineering Economics Division. The January question was: *Define the term, "engineering economics."* From among the letters received in answer to this question the two following have been chosen by the committee for publication:

From L. STANDISH HALL, M. Am. Soc. C.E.—"Economics is defined as the science that investigates the conditions and laws affecting the production, distribution, and consumption of wealth, or the material means of satisfying human desires. Engineering is the art and science by which the properties of matter and the sources of power in nature are made useful to man in structures, machines, and manufactured products (*Webster's New International Dictionary*, 2d edition.)

"Engineering economics, therefore, connotes the general theory of equilibrium between wages, rents, and interest either under a system of price competition or of price monopoly as affecting engineering structures, machines, and products. It embraces a study of the fundamentals of production, business organization, price and price levels, wages and employment, interest and profits as applied to leading engineering institutions and problems.

"It covers the functions of industrial business and economic organization as they bear upon the interests of the stockholder, the employee, the market, the community, and the general public. Under modern society, engineering economics embraces a large section of the entire field of economics.

"It involves an examination of leading current economic problems having an engineering solution, and their correlation with business cycles, foreign trade, labor organizations, monopolies, and the government control of private industry. With the increasing tendency toward the development of large public projects, there is a practical application of these laws to the problems of government.

"Under a state of war there must also be considered the changes resulting from the engineering adjustment of industry to the demands of a war economy."

From E. E. ZELLER (through courtesy of E. E. BOTTOMS, Assoc. M. Am. Soc. C.E.)—"Engineering is a way of thinking in terms of constant energy values (force and distance typifying work) to the end that construction, operation, and maintenance of utility in structures may be most efficiently accomplished.

"Economics is a way of thinking in terms of variable energy values (supply and demand typified by price) to the end that construction, operation, and maintenance values in structures of utility may be most efficiently accomplished.

"Each way of thought is self-sufficient in its primary field. However, making useful things and evaluating the utility of things can no more suffice in separate spheres than progress can be limited to past or future values. Progress, demanding present solutions, requires the thing to be evaluated before it is made and/or its value to be proved by its utility.

"Engineering economics as a science is therefore that united sphere where units of energy justify expenditure of value equivalents, and units of utility justify expenditure of value equivalents. Its solutions are static only at the instant of computation for the reason that value is a variable with time and utility. Engineering economics as an art is therefore skill in reconciling constant findings with variable values."

The question for this month follows:

> *"Should the relationship between the net depreciation reserve set up on a public utility company's books and the value of the property used and useful in rendering service, affect the amount allowed to be earned for 'depreciation' in arriving at rates?"*

Let it be remembered that answers should be addressed to

Engineering Economics Division
R. A. Willis, Secretary
1306 Syndicate Trust Building
St. Louis, Mo.

and should be received not later than March 25. Those selected for publication will then appear in the May issue of CIVIL ENGINEERING.

By-Laws Amended Recognizing Code of Ethics

AT ITS January meeting, the Board of Direction amended the Society's By-Laws, Article I, Section 10, relating to "Election of Members." This action followed Constitutional procedure, having been initiated at the Chicago Meeting last October. The purpose was to emphasize the Code of Ethics as a standard of required professional practice.

For this purpose the first sentence of the second paragraph of Section 10, which now reads:

"All elected candidates shall be duly notified and shall subscribe to the Constitution and By-Laws of the Society."

was amended to read as follows:

"All elected candidates shall be duly notified and shall subscribe to the Constitution, By-Laws and Code of Ethics of the Society and agree to conform thereto."

A third paragraph, entirely new, was added to the same Section 10, reading as follows:

"Violation of the Code of Ethics of the Society by any member may be deemed conduct justifying procedure for the expulsion of such member under Article III, Section 2, of the Constitution."

These amendments are now effective and will be included in the new Yearbook to appear in April 1942.

Annual Business Meeting

AT THE CLOSE of the morning session of the Annual Meeting of the Society on January 21, a business session was held with President Fowler presiding. Following required procedure, a proposed amendment to Article II of the Constitution, "Membership," and Article IV, "Dues," was presented for action. Notice of this amendment had been duly sent to Corporate Members under date of December 5, 1941. There being no discussion or further amendment, it was unanimously voted that this amendment be sent to letter ballot.

Recommendation was received from the Board of Direction relative to a letter proposed to be sent to the President, reaffirming the support of the Society in the present national emergency. This letter was unanimously approved and endorsed by formal vote. An item giving details of this letter appears elsewhere in this issue.

The Report of the Tellers was received, in the form given in the February number, page 115. The President declared the candidates elected to their respective offices. He further asked that Past-Presidents Davison and Hogan escort the new President, E. B. Black, to the platform. After the formalities of presentation, induction, response, and appreciation of the retiring President, F. H. Fowler, the business meeting adjourned.

Districts and Zones for 1942

THE Board of Direction announces that there will be no changes in the boundaries of Districts and Zones for the year 1942. This action was taken at the January meeting of the Board. Announcement is made in accordance with the Constitutional requirement that all members be notified before April 1 of each year.

Preserve Your "Proceedings"

THE Publications Committee of the Society wishes to pass along a suggestion to all members of the Society that they save copies of PROCEEDINGS until they have satisfied themselves that the papers, reports, and discussions have appeared in TRANSACTIONS. This necessity is especially compelling at the present time.

Certain matters never find their way into TRANSACTIONS. Such, for example, is the Report on Pile Driving Formulas in the May 1941 issue of PROCEEDINGS and its subsequent discussion. Such progress reports appear only once and hence the form in which they appear in PROCEEDINGS is the only one that will be available.

Beyond this, there is further need of preserving desired material because of uncertainty about the printing of the 1942 TRANSACTIONS. The Society is facing unusual conditions, some known and some unknown. For example, it is to be realized that the paper shortage is acute and that this may affect the amount of printing permissible. The net result is that all copies of PROCEEDINGS for 1941 and 1942 should be retained until the prospects are more certain. The Publications Committee hopes that before the end of the summer it can give definite advice.

Society Reiterates Pledge to the President

THE heartiest support of the Society in all national efforts was reaffirmed in a recent letter to the President of the United States. This communication, authorized and approved by the Board at its concurrent meeting, was officially approved by the Annual Meeting of the Society on January 21 in the following form:

"January 21, 1942

"THE PRESIDENT
White House
Washington, D.C.

"SIR:

"On July 23rd, at the Annual Convention in San Diego, the American Society of Civil Engineers adopted a resolution 'pledging to the President of the United States our complete support of his efforts in behalf of the National Defense and our unqualified endorsement of any action which, as Commander-in-Chief of the military forces, he may deem necessary in furthering defense.'

"At the Annual Meeting of the Society on this date, our membership desires to reiterate our pledge of support. We are already increasing our efforts, both in the armed offense and in production, and are studying further methods to make these efforts more effective in cooperation for the ultimate victory.

"Very truly yours,
GEORGE T. SEABURY
Secretary"

Promotion for Members in the Armed Services

SEVERAL members of the Society are among the engineer officers nominated by President Roosevelt for temporary promotion. Those recommended for promotion from the rank of brigadier general to that of major general include John C. H. Lee, who commands the Second Infantry Division; Thomas M. Robins, Deputy Chief of Engineers; and Brehon B. Somervell, Assistant Chief of Staff, Supply Division (G-4), War Department General Staff.

Similarly, Col. David McCoach, Jr., Assistant Chief of Engineers, has been recommended for promotion to the rank of brigadier general. In the Philippines Col. Hugh J. Casey is among those recommended for advancement to the rank of brigadier general "for having extraordinarily distinguished themselves by their leadership and gallantry in the severe fighting now [January 24] in progress on the Bataan Peninsula."

Appointments of Society Representatives

J. T. L. McNEW and ROSS WHITE, Members Am. Soc. C.E., were appointed to represent the Society at the meeting of the American Association for the Advancement of Science held in Dallas, Tex., December 29, 1941–January 3, 1942.

ENOCH R. NEEDLES, M. Am. Soc. C.E., has been appointed the Society's representative (with authority to designate an alternate) on a Committee to Study Post-War Economic Conditions.

News of Local Sections

Scheduled Meetings

ARIZONA SECTION—Two-day meeting of the Fifth Annual Roads and Streets Conference, sponsored by the Arizona Section, the Arizona Highway Department, and the University of Arizona at the University on March 20 and 21, at 9:30 a.m.

CENTRAL OHIO SECTION—Luncheon meeting at the Fort Hayes Hotel on March 19, at 12 m.

CLEVELAND SECTION—Luncheon meeting at the Guildhall Restaurant on March 2, at 12:15 p.m.

DAYTON SECTION—Luncheon meeting at the Engineers Club on March 16, at 12:15 p.m.

DISTRICT OF COLUMBIA SECTION—Meeting at the Cosmos Club on March 17, at 8:15 p.m.

ILLINOIS SECTION—Dinner meetings of the Junior Section at the Central Y.M.C.A. on March 3 and March 16, at 6 p.m.

METROPOLITAN SECTION—Technical meeting in the Engineering Societies Building on March 10, at 8 p.m. (Joint meeting with New York section, American Welding Society.)

MIAMI SECTION—Dinner meeting at the Alcazar Hotel on March 5, at 7 p.m.

NEBRASKA SECTION—Dinner meeting on March 13, at 6:30 p.m.

NORTHEASTERN SECTION—Dinner meeting at the Engineers Club on March 23, at 6 p.m., sponsored by the Junior Association.

NORTHWESTERN SECTION—Dinner meeting at the Minnesota Union on March 2, at 6:30 p.m.; dinner meeting of the Junior Chapter at Coffman Union on March 16, at 6:30 p.m.

PHILADELPHIA SECTION—Dinner meeting at the Engineers Club on March 10, at 6 p.m.

SACRAMENTO SECTION—Regular luncheon meetings at the Elks Club every Tuesday at 12:15 p.m.; dinner meeting of the Junior Forum at Harts Restaurant on March 11 at 6 p.m.

ST. LOUIS SECTION—Luncheon meeting at the York Hotel on March 23, at 12:15 p.m.

SPOKANE SECTION—Regular luncheon meeting at the Davenport Hotel on March 12, at 12 m.

TACOMA SECTION—Dinner meeting at the Lakewood Community Center on March 10, at 6:30 p.m.

TEXAS SECTION—Spring meeting on March 13 and 14; luncheon meeting of the Dallas Branch at the Dallas Athletic Club on March 2, at 12:10 p.m.

TRI-CITY SECTION—Dinner meeting at the Le Claire Hotel on March 13, at 7 p.m. Inspection of Riverside Power Station (steam plant) and Moline Water Power Plant (hydroelectric) will precede dinner. Assembly for inspection trip will be at the Riverside Plant, Bettendorf, Iowa, at 4:30 p.m.

UTAH SECTION—Dinner meeting jointly with the Utah Society of Professional Engineers at the Art Barn on March 18, at 6:30 p.m.

Recent Activities

BUFFALO SECTION

Several phases of city planning were discussed by Elwin G. Speyer at the December 9 meeting of the Buffalo Section. Mr. Speyer is consulting engineer for the City (Buffalo) Planning Board. "The effectiveness of the [planning] agency," Mr. Speyer pointed out, "depends upon the support of the people who hold it responsible and it must have the support of the people." Another aspect of planning, covered by Mr. Speyer, was the problem of blighted areas. Contrary to popular belief, he said, blighted areas are not always the result of poor zoning, but more often have been aggravated by economic conditions. As a case in point, he traced the growth of the city of Buffalo and its effect on the development of blighted areas within the municipality. During the annual business meeting, held at this time, the following officers were elected: William T. Huber, president; Norman M. Herthe, vice-president; Charles R. Velzy, secretary; and Newell L. Nussbaumer, treasurer.

On January 28 Andrue Berding, foreign affairs expert for the *Buffalo Evening News* and a former Associated Press correspondent in Berlin and Rome, spoke on the subject, "The World as I See It." In his report on the Annual Meeting of the Society, E. P. Lupfer called special attention to the fact that honorary membership in the Society was conferred on Col. William Kelly at the meeting. Colonel Kelly then spoke briefly, expressing his appreciation of the honor accorded him.

CENTRAL ILLINOIS SECTION

The guest of honor and speaker at the annual meeting of the Section, which took place in Champaign on December 18, was E. L. Durkee, erection engineer for the Bethlehem Steel Company. Mr. Durkee gave an illustrated lecture on the erection of the new Rainbow Bridge at Niagara Falls, N.Y., on which project he recently served as resident engineer. President-elect W. H. Wisely also spoke, asking the continued cooperation of the Section membership during the coming year, and stressing the importance of such cooperation in view of the war situation. The other officers elected at this time were W. B. Worsham, first vice-president; H. E. Babbitt, second vice-president; and H. P. Evans, secretary-treasurer.

CINCINNATI SECTION

An audience of over a thousand turned out for a joint meeting of the Section and the Cincinnati Technical and Scientific Societies Council, which took place at the University of Cincinnati on January 21. The feature of the occasion was a talk by Samuel G. Hibben on the subject of blackouts. Dr. Hibben, who is Director of Applied Lighting for the Westinghouse Electric and Manufacturing Company, Bloomfield, N.J., illustrated his talk with many interesting demonstrations of new lighting and light-reflecting devices, whose use will promote safety during blackout periods.

CLEVELAND SECTION

At the annual meeting of the Cleveland Section, which was held on January 5, the speaker and guest of honor was Prof. R. B. Willis, of the University of Western Ontario, London, Ontario, Canada. Professor Willis spoke on the St. Lawrence Seaway, pointing out the fact that a shortage of power exists in both New York State and Canada, and that if the energy could be made available soon and at a cheaper rate it would be one justification for setting up the power project. "Should the power plant be

constructed at International Falls," he stated, "it would generate 2,200,000 hp, which would be equally divided between the United States and Canada." On the debit side of the undertaking is the fact that if ocean-going vessels use the Seaway, it would mean that eight American harbors will have to be deepened and port facilities adjusted to take care of ocean-going craft. The next item on the program was an innovation in the form of a magician's performance, the "magician" being E. H. Sipes, of the Ravenna Ordnance Plant, who is noted for his skill in the art of magic. During the annual business meeting the following officers were elected for the coming year: George E. Barnes, president; G. Brooks Earnest, vice-president; and Leland A. Olson, secretary-treasurer.

The December meeting was addressed by A. J. Ackerman, director of engineering for the Dravo Corporation, Pittsburgh, Pa., who spoke on "Construction versus Engineering." Mr. Ackerman stressed the fact that considerable money has been wasted in misplanning and in misapplied design. He illustrated his talk with slides of several projects.

Colorado Section

Discussion of firearms comprised the technical program at the January meeting, which was held in Denver on the 12th. The first speaker was Carl H. Knoettge, who is connected with the Denver plant of the Remington Arms Company and who has made the study of firearms a hobby. Mr. Knoettge outlined the various types of ammunition in present-day use for small arms and described the principal types of semi-automatic rifles, circulating several specimens among the members. The meeting concluded with a talk by William Bruce, director of the Armory of the Denver Ammunition Plant.

District of Columbia Section

Lack of space made it necessary to turn almost fifty away from the annual dinner, which attracted the record attendance of 300 members and guests. Following an annual custom, Society officers were guests of the Section on this occasion, the list including President Black, Past-President Fowler, Vice-President Stevens, Director Requardt, and Secretary Seabury. The principal speakers were Maj. Gen. Eugene Reybold, Chief of Engineers, Corps of Engineers, U.S. Army, who discussed "The Role of the Corps of Engineers in Modern War," and Capt. Louis B. Combs, assistant chief of the Bureau of Yards and Docks, whose topic was "Functions of the Civil Engineer Corps in the Naval Establishment." Messrs. Black and Seabury also spoke, as did T. Keith Legare, executive secretary of the National Council of State Boards of Engineering Examiners.

Duluth Section

On January 19 the Duluth Section elected the following new officers: Edwin G. Fulton, president; Ronald F. Scott, first vice-president; S. W. Tarr, second vice-president; William E. Hawley, secretary; and John Carson, treasurer. The technical program on this occasion consisted of an account of a trip to Russia, given by Frank Hutchinson, Duluth consultant.

At the December meeting K. F. Busyn, deputy sheriff of St. Louis County, discussed the problems of defense as viewed from the sheriff's office and the place of civilians in defense. A talk on critical events in Shanghai and the plight of Le Roy Pharis, member of the Section, who is reported to have escaped from Shanghai during the Japanese attack there, concluded the meeting.

Los Angeles Section

"The civilian engineer can best help the government in this emergency by remaining at his chosen work, perfecting himself therein, and expanding his work to include others," according to Capt. Thomas E. Messer, who addressed the January meeting of the Los Angeles Section. Captain Messer, who is chief of the Operations Division of the U.S. Engineer Office at Los Angeles, also stated very emphatically that each engineer should train a key man in his office to take his place if he should be called to duty, so that the organization will not be disrupted. Vernon Gulick, who has been with the Standard Oil Company, in Yokohama, for the past twenty-six years, next related his personal experiences in Japan, covering the diplomatic high lights of his stay there. Mr. Gulick was on the seas between Manila and Honolulu when war was declared. The last speaker of the evening—Harold W. Kennedy, assistant county counsel and executive director of the Los Angeles County Defense Council—discussed "Civilian Defense and How It Is Working in Los Angeles County."

Metropolitan Section

At the January meeting of the Section Fred Lavis, New York consultant, spoke on "Engineering Opportunities in Latin America." Mr. Lavis, who has acted as adviser on transportation to the Ministry of Public Works of Venezuela and has had much experience in engineering work in Latin America, stated that while there is a substantial demand for engineers in South America, they are generally engaged in the United States by engineering firms and industrial organizations that are designing or constructing projects. His discussion was followed by several reels of colored motion pictures showing railroad construction in Venezuela and the building of the trans-Andean highway between La Guaira, Caracas, and the border of Colombia.

Michigan Section

A joint dinner meeting with the University of Michigan Student Chapter took place on December 17. The list of guests included President Fowler, who spoke briefly on the national defense construction program, and Past-President Riggs. Professor Riggs presented certificates of life membership to several members. The technical program consisted of an illustrated lecture on "Pre-Columbian Indian Calendars." This was given by Dr. Carl E. Guthe, director of the university museum, who explained how, by addition and multiplication, the early Indian tribes foretold the seasons and the passage of time.

Maryland Section

The principal speaker at the January meeting of the Section, which was held in Baltimore on the 28th, was Ferdinand Hamburger, associate professor of electrical engineering at the Johns Hopkins University. Dr. Hamburger discussed the properties of radio waves and some of their applications to communication. With a laboratory set-up of an extreme short-wave broadcast unit, he then demonstrated the reflection and directional effect of certain radio waves. Brief talks by Gustav Requardt, Director of the Society, and Paul Holland, chairman of the Section's Committee on Professional Objectives, concluded the program.

North Carolina Section

The annual meeting of the North Carolina Section took the form of an all-day session, which was held at Duke University, Durham, on January 10. Except for a paper on "Protection of Industrial Plants Against Sabotage"—read by Walter C. Robinson, special agent for the Federal Bureau of Investigation at Charlotte—the morning session was devoted to business discussion and the reading of committee reports. Following a noon luncheon, a technical program was presented. This consisted of talks by R. E. Tarbett, engineer for the U.S. Public Health Service, who discussed the "Protection and Maintenance of Public Water Supplies in War-Time Emergencies"; and M. F. Trice, industrial hygienist for the Division of Industrial Hygiene of the North Carolina State Board of Health, whose subject was "Accident Prevention and Control of Occupational Hazards on Construction." The annual election of officers resulted in the selection of Thomas F. Hickerson for president, and Joseph N. Stribling for junior vice-president. George H. Maurice continues as secretary.

Northwestern Section

On January 5 members of the Northwestern Section heard a timely talk by Louis Yager, assistant chief engineer of the Northern Pacific Railway. Mr. Yager's talk was entitled "An Engineer's Impressions of the Orient as Related to the Present Conflict in Japan." At this session prizes for civil engineering students at five educational institutions in the Section were authorized for 1942. The speaker at the February meeting—held at the University of Minnesota on February 2—was Addison H. Douglas, Minnesota director of the Public Work Reserve.

Providence Section

The Providence Section held its annual dinner and reception for the new President and Secretary of the Society on January 30. In addition to President Black and Secretary Seabury, the list of guests included C. M. Spofford, newly elected Vice-President of the Society. All discussed various phases of Society activities and interests. Chairman H. A. Whitcomb was in charge of the program.

San Diego Section

A talk on the construction of Camp Callan was the feature of the January 22d meeting of the San Diego Section. This was given by Maj. Ben Huntington, who discussed construction costs and brought out important facts in regard to the types of contracts let. It was estimated that, on this project, the cost of the buildings was $600 per man, and the cost of utilities $100 per man. The camp was designed for 8,500 men. Major Huntington emphasized the fact that it was impossible to come to any conclusions as to the most economical contracting because of the emergency nature of the project and the time element involved.

It has been announced that Jack Heckelman, sophomore engineering student at San Diego State College, is the recipient of the $25 scholarship offered by the San Diego Section for the current academic year.

South Carolina Section

The annual meeting of the South Carolina Section took the form of a joint session with the South Carolina Society of Engineers. The gathering was held at Columbia on January 9 and consisted of morning, afternoon, and evening sessions. The list of speakers scheduled for the various programs included Dr. Jacob Feld, New York City consultant; A. M. Quattlebaum, assistant professor of civil engineering at Clemson College; W. L. Hardeman, assistant to the South Carolina State Highway Commissioner; F. R. McMeekin, of the South Carolina Electric and Gas Company; and Brig. Gen. Holmes B. Springs, South Carolina State Director of Selective Service. During the annual business meeting P. S. Monk was elected president for the coming year. Albert E. Johnson will continue as secretary-treasurer.

Tacoma Section

In spite of foggy weather and hazardous driving there was a representative turnout for the annual meeting and Ladies' Night, which took place on January 10. The evening got off to a good start with a turkey dinner. During the meal and later Mrs. Edith Lundgren, harpist, presented a musical program, and Fred Veatch led the group in community singing. Following the presentation of guests from other Sections, officers for 1942 were installed. These are Lothrop Crosby, president; Charles H. Williams, vice-president; and Clyde Kimbrough, secretary-treasurer. Dancing and bridge concluded the evening.

Texas Section

On January 5 members of the Dallas Branch of the Texas Section met to hear a talk on civilian defense. The speaker was Ayres Compton, Civilian Defense Counselor, who discussed "Ramifications of Civil Defense as Applied to the Home Front."

The Lower Rio Grande Branch met at Harlingen, Tex., on January 23, with W. F. Heath as master of ceremonies. The technical program included the review of several articles in recent issues of CIVIL ENGINEERING. Then H. F. Bahmeier, engineer for the U.S. Bureau of Reclamation, presented a paper entitled "Irrigation Development in the Western States," in which he discussed the difficulties attending many early developments in the United States and compared the projects with developments in Australia. The factors usually responsible for such failures, he said, were lack of storage facilities, inclusion of lands unsuited to irrigation, and the practice of over-irrigating. These conditions, he pointed out, are now being remedied on many projects by the construction of large storage and regulatory works and through comprehensive river basin-wide surveys. In the ensuing general conference the spray system of irrigation was discussed at some length. Its principal advantages appear to be elimination of over-irrigation and the hastening of maturity of some crops. The disadvantages brought out were the high cost of equipment and the possibility of concentration of salts in the topsoil, since the leaching effect of ordinary irrigation is absent. Measurement of irrigation water was also discussed, and it was brought out that in the Lower Rio Grande Valley irrigation districts having lined canals and pipeline systems required continuous irrigation, while the districts having wide unlined canals with considerable storage capacity usually did not require night irrigation.

Toledo Section

New officers for the Section, elected at the December meeting, are as follows: H. A. Stepleton, president; Russell W. Abbott, first vice-president; L. M. Friedrich, second vice-president; and W. P. Sanzenbacher, secretary-treasurer. A talk on pile foundations—by R. D. Chellis, assistant structural engineer for Stone and Webster, of Boston—comprised the technical program. On January 7 Hawley Simpson, research engineer for the American Transit Association, addressed the group on the subject of mass transportation movements, supplementing his talk by sound motion pictures.

Tri-City Section

A regular meeting of the Tri-City Section took place at Rock Island, Ill., on January 16. Following a dinner, Col. Carl A. Waldman spoke on "Modern Military Equipment." Colonel Waldman, who is officer in charge of manufacturing at the Rock Island Arsenal, began with an account of the origin and growth of the Arsenal and then showed a series of slides illustrating the many ordnance items being produced there, together with data on their use and performance.

Utah Section

A symposium on the Office of Production Management was the feature of the January meeting of the Utah Section, which took the form of a joint session with the Utah Society of Professional Engineers. The speakers were Ralph E. Bristol, district manager for the OPM, who discussed the organization and problems of that agency and its function in the emergency; and Frederick B. Hyder, engineer-analyst for the OPM, who gave a detailed account of the workings of the priority plan and showed how it was designed to help national defense and assist industries directly connected with national defense.

Student Chapter Notes

Brown University

At the fifth meeting of the Brown University Chapter—held on January 14—Arthur S. Lippack gave a talk on a local volunteer fire department, to which he belongs. Mr. Lippack, who is a member of the Chapter, outlined the organization of the department and stressed the importance of such an agency at the present.

Iowa State College

"Unfinished Rainbows," a pictorial account of the manufacture of aluminum, was shown on January 28 at a meeting, to which the Iowa State Chapter had invited the other student groups on the campus. The film, which was furnished through the courtesy of the Aluminum Company of America, shows not only the actual making of aluminum, but many of the processes involved in its shaping for use. During the thirty minutes of running time it takes the audience from bauxite mine to the finished airplane and emphasizes the role of the company in the defense program. The group adjudged it one of the most thrilling movies seen in a long time. The program concluded with a talk by Lieutenant McNamara, second in command of construction at the Des Moines Small Arms Plant, who discussed the various problems encountered in construction at the plant and their solution.

New York University

On January 14 the evening division of the Chapter heard a talk on city surveying, given by H. N. Bartlett, city surveyor and instructor at New York University. By presenting the historical background, Mr. Bartlett showed how an apartment house plot might have developed from the old farm lands in New York City. He then explained the various steps a city surveyor would normally take during the construction of an apartment house, illustrating these steps with drawings made in his office during the building of a typical structure.

Rhode Island State College

The Rhode Island State College Chapter reports that two meetings were enjoyed in January. At one of these sessions Noel MacKinnon, member of the Chapter, gave an illustrated lecture on the Golden Gate Bridge. At the other Harry T. Immerman, chief engineer of Spencer, White and Prentis, of New York City, spoke on the subject of "Underpinnings."

ITEMS OF INTEREST

About Engineers and Engineering

Civil Engineering for April

Tunnel construction under the Shawangunk Range for the New York City Board of Water Supply is the subject of a paper by Fred W. Stiefel, chief engineer of the construction firm now doing this work. Popping rock, large quantities of water, and methane gas were a few of the obstacles to be overcome. For long stretches the roof had to be supported by steel braces and in one place special bits were made to drill extremely abrasive rock. With this paper is a group of excellent tunnel photos.

Professor Soneson of Purdue has made a study of stresses found in the two-hinged steel arches used to support the roof and balconies of a large gymnasium. Gages attached at critical points before erection were read after erection, but before the building was put in use, to determine actual dead-load stresses. They were also read when the balcony held its maximum live load of spectators. Results are compared with the theoretical stresses used by the designer.

A review of a live-load formula proposed by the American Standards Association's Sectional Committee A-58 on Building Code Requirements for Minimum Design Loads in Buildings is given in a paper by C. W. Barber. Much of the success of earlier work along these lines is attributable to the procedure followed of subjecting proposed requirements to critical review through publication in engineering journals. This paper is presented in the hope that it will draw forth general comment.

"Concrete Production for Friant Dam," by C. T. Douglass, will be the third in the series describing the construction of this important link in the huge Central Valley Project. The complicated routing of aggregates, pumicite, cement, and water is described, giving the actual timing used to feed the mixers to insure proper combination of all elements.

Civilian Engineers for the War Program

How many civilian workers does it take to keep a soldier in the army? The estimates vary. Engineers are among the most important of the civilian workers supporting our "armed forces." Whatever the ratio between the armed and civilian forces, the expanding war program is constantly demanding a new "high" in the estimates for engineers needed in defense agencies and industries.

The Civil Service Commission, recruiting for the federal Civil service, is accepting applications for all grades and branches of engineering. Engineer examinations, some recently consolidated and modified, are listed below, with the number of the official announcement that gives all details. None requires a written test. For the Junior grades, $2,000 a year, applicants are rated on their engineering education; no experience is required.

Junior engineer, aeronautical, naval architecture, and marine engineering, Announcement 122. The usual college engineering course must include work in the optional branch chosen unless the applicant has taken an appropriate defense training course, or has had prescribed experience in the branch chosen. Age limit—40.

Junior engineer, all other branches of engineering, Announcement 172. A new feature is that certain college courses (other than the usual engineering courses) may also be accepted if supplemented by appropriate engineering defense training courses. Previous Announcement 51 admitted senior college students who will complete prescribed courses by June 30, 1942. The new examination also admits those who will complete such courses by June 30, 1943. Age limit—35.

In the upper grades, applicants are rated on education experience, and record of accomplishments:

Engineer (other than chemical, and naval architect) $2,600 to $5,600 a year, Announcement 173. Especially needed, particularly in the associate and assistant grades, are engineers experienced in the following fields: Aeronautical, Heating and Ventilating, Industrial, Sanitary, Hydroelectric, Irrigation, Construction-Estimating, Structural, Explosives, Plumbing, Public Health, Welding, Hydraulic.

For most of the upper grades the age limit is 60. Age limits do not apply to veterans granted military preference, up to the retirement age. Non-veterans over the age limit will not be eligible for permanent appointment; but they may apply, and if they meet all but the age requirements, may be listed for defense needs not met through normal means.

There are also opportunities in the subprofessional and lower grades:

Technical assistant (engineering) $1,800 a year, Announcement 177. Three years of a four-year college course must be shown including work in mathematics, physics, and allied engineering subjects. Appropriate engineering defense training courses will satisfy a part of the requirements. The age limit is 53.

Engineering aid, photogrammetric and topographic options, $1,440 to $2,600 a year, Announcement 206. This examination has just been re-issued to add the junior engineering aid position paying $1,440 a year, and to modify the requirements in order to attract additional applicants needed in connection with the national defense mapping program recently set up in the War Department. Appropriate civil engineering experience, partly in the optional branch chosen, and high school education (or additional engineering experience), are required. Provision is made for the substitution of appropriate college study or defense training courses, or study in a resident night school or technical institute, for the engineering experience. No substitution will be allowed, however, for the specialized experience or training in photogrammetry or topography. Age limit—53.

Other opportunities for engineers are offered by the following:

Engineering draftsman, junior to chief grades, $1,440 to $2,600 a year, Announcement 174. This examination supersedes a number of others and includes 20 different optional branches. Engineering education is one of the alternative or substituted requirements. Age limit—55.

Applications for all these positions are being accepted for several months or until further notice. However, qualified engineers are urged to apply at once—unless they have already applied in a recent examination and are eligible—for the position desired. Full information is given in the announcements, which may be obtained, with the proper application forms, at any first- or second-class post office or from the U.S. Civil Service Commission, Washington, D.C.

Prof. N. G. Neare's Column

Conducted by

R. Robinson Rowe, M. Am. Soc. C.E.

"Gentlemen, and particularly you structural engineers, I hope it isn't beneath your dignity to join in a learned discussion of the stability of card tables. Whether kibitzer or kibitzee," continued Professor Neare, "you are welcome to join in the discussion of the January problem—to find mentally the weight of a Stewart card table, knowing that certain weights set at two corners produce live-plus-dead leg reactions of 1, 2, 3, and 4 lb."

"The premises are inconsistent," opened Joe Kerr. "With an inflexible top, leg shortening is proportional to leg reaction. Deflection of center of top is the mean shortening of two legs on a diagonal—2 units if computed along the 1–3 diagonal or 3 units if computed along the 2–4 diagonal. Hence these reactions can't obtain with the inflexible top."

"True," chimed in Cal Klater, "but the reactions were not said to be in any particular order. So the order could be 1, 2, 4, and 3, clockwise or counterclockwise. No other order is possible. In either case the table weighed 6 lb."

"Right," conceded the Professor. "Did you compute that by the criss-cross method or mental logic?"

"Mental, as specified," answered Cal. "The unknown table weight can be considered concentrated at the intersection of the diagonals. Moments about diagonal 1–4 disclose 3 stacks of chips on the corner above the 4-lb reaction; moments about diagonal 2–3 show only one stack over the 3-lb reaction. Total reaction (10 lb) less

4 lb of chips leaves 6 lb for the table weight."

"Well put!" complimented Professor Neare.

"And fair imagination," added Amos Keatow with a chuckle. "I know because I was there, at one of the corners without any chips. The big winner had them all, the lucky bum, 3 lb of them. The 1-lb load was just an empty bottle. The conference had ended with the dawn."

"So much for that," concluded the Professor. "Now here's one for discussion at our May meeting—one over which our long-shot statistical engineers can argue actuarially.

"Many of us have read with some alarm that the Japanese in this country are reproducing at the rate of 24 per thousand per annum while the birthrate of our citizenry is only 18. For either group the death rate is 11.

"Suppose now that these rates become invariant, that immigration and emigration cease, and that our population includes 129,000,000 citizens and 92,000 alien Japanese. When will the latter group exceed the former?"

(This month the fictitious Klater consolidates the mental geniuses of, chronologically, A Nuther Nutt (sic), Maj. Ray Adams, Richard Jenney, Weston Gavett, L. W. Neubauer, and Thomas Oakley.)

Frontier Experiences with an Old Transit

By E. B. BLACK, PRESIDENT AM. SOC. C.E.
BLACK AND VEATCH CONSULTING ENGINEERS, KANSAS CITY, MO.

PERHAPS the story of the old surveyor's transit used by my father for more than forty years will be of some interest to civil engineers. Mention of this instrument was made in the February issue, page 107. This transit was purchased by Father, second-hand, from a Chicago dealer in 1862, for use in subdividing Government lands under a contract my grandfather, Samuel S. Black, had signed with the Government. It lacked two of the gadgets it now boasts, the principal one being the telescope level Father had put on when he needed a level instead of a transit. In those days no surveyor could afford both.

The Government land to be subdivided was in south-central Nebraska, in the vicinity of old Fort Kearney, which as I recall was very near the present City of Kearney on the north side of the Platte River. Father was one of the members of the survey party and the transit was one of the very necessary surveying instruments used in this work. Grandfather's party went from the old home town of Mt. Sterling, Ill., to Fort Leavenworth, Kans. Here a wagon train was outfitted, a guard of U. S. soldiers was provided, and the party proceeded to the Fort Kearney district 250 miles to the northwest of Leavenworth.

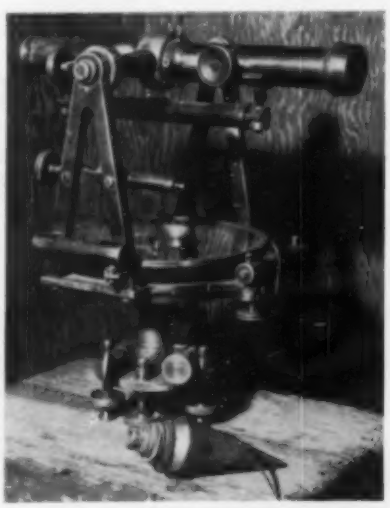
Wild game as well as Indians was on every hand and Father used to tell about the various kinds of meat, fowl, and fish served by the camp cooks. The only dish he remembered refusing was beaver-tail soup. Buffalo and venison were ordinary items of diet, and much of the hunting was done with hounds. In 1863 the Indians got restless and the survey parties moved in close to Fort Kearney. On July 4, the Army telegraph reported the fall of Vicksburg. Shortly after that the Indians made it necessary for the whites to get out, the surveys were stopped, and the survey party returned to Illinois.

In 1884 Father took the transit to southwestern Kansas, and one of his first jobs was to stake out the town of Tuzalon, about fifty miles south and west of Dodge City, on the Jones and Plummer trail, which ran from Dodge City to the Jones and Plummer ranch in north Texas. The trail was used by wagon trains freighting supplies to that section of the country, which was not then served by railroads.

Tuzalon never struck water so Father staked out the town of Meade, four miles to the northwest. With the possible exception of the original town of Liberal, Kans., Father made the first surveys for practically all the towns in Kansas in the 100-mile stretch between Meade and the west line of the state, and south of the Arkansas River. He surveyed Beaver, Okla., for George Scrannage, a personal friend of Grover Cleveland.

In later years I covered many miles with Father and the old transit on town-lot and irrigation-ditch surveys. It was once my job to resurvey—without Father's help—a large irrigation ditch in the 'Neutral Strip' of Oklahoma, which another surveyor had staked out while keeping the level rod always in front of his level, continuously pointed in the direction his ditch was supposed to run. This method did not allow for the Earth's curvature and water never ran down the ditch built on the original survey, but it did run the full ten miles of ditch as resurveyed by Father's old transit.

It was a part of the official duty of County Surveyors in Kansas to make semi-annual observations on Polaris and to determine and report the declination of the magnetic needle. It was my job to help Father make these observations, usually by holding a light so that the transit's cross hairs were illuminated, to catch Polaris at eastern elongation. Then true north would be calculated and staked on the ground for future reference, and the needle declination reported.



A VETERAN OF PIONEER MIDWESTERN SURVEYS

Old Transit Used for More Than Forty Years by Moses Black, Kansas Surveyor

When the solar compass attachment for transits got within the financial reach of some surveyors, Father wished to buy one. With such an attachment, true north could be determined during the day and observations on Polaris could be stopped. So, being Scotch-Irish—mostly Scotch— Father tried to trade the old transit to the manufacturer for a modern one with the solar compass attachment. However his argument that the age of the transit made it of unusual value was ruined because some one had just previously given or traded a still older transit of the same manufacturer.

And I am glad that the trade never went through. For it was during my long (in hours) trips with Father through the frontier country of Kansas and Oklahoma, in horse-drawn rigs and on foot, that I got my first glimpse of an engineer's life, my first introduction to mathematics (through Robinson's ten-place logarithm tables), and the urge to carry on in the modern development of the profession followed by my father and grandfather.

Incidentally, I am thankful I had frontier experience; that we went through Indian scares; shot coyotes from the front door; lived on a ranch in a sod house; and attended the wedding of Eva Dalton, the only sister of the Dalton Gang—and by the way Mother prepared a part of that wedding supper. I'm certain that none of these things would have happened if the old transit had not tied us to these experiences which were a necessary part of our country's development.

Opportunities in Sanitary Corps of the Army

THE Sanitary Corps of the U.S. Army announces opportunities for 80 qualified civil or sanitary engineers to be commissioned as first lieutenants for the duration of the present emergency and a period of six months thereafter. Applicants must be under 37 and physically qualified.

Although no examination will be given, applicants must have completed a four-year course and received a bachelor's degree in civil or sanitary engineering from an approved college or university. They must also have had at least four years' actual experience in sanitary and public health engineering. The master's degree in sanitary engineering may be substituted for one and a half years of experience.

The base pay of a first lieutenant is \$2,000 a year plus \$18 a month for subsistence and \$40 for rent, if single, or \$36 a month for subsistence and \$60 for rent, if married. Applicants should write to the Surgeon General, U.S. Army, Washington, D.C., giving a complete statement as to age, education, and experience, together with a summary of duties performed under each position held.

Army Personnel Placement Agencies

The War Department has established recently in the Adjutant General's office in Washington, D.C.; in each Corps Area of the Army; and in each War Department arm, service and bureau, an Information and Personnel Placement Agency. The records of all persons who offer their services to the Government are to be acknowledged, classified, and evaluated. If the applicant appears to have potential value in any capacity to the War Department, a questionnaire is handed or mailed to him at once.

The questionnaires are then tentatively classified. If a commission as an officer in one of the services appears justified, and if that service has authorization to procure additional officers from sources other than an officer's candidate school, the questionnaire is forwarded there, and appropriate steps are taken to have the applicant commissioned.

Questionnaires of other applicants are forwarded to the Civilian Personnel Branch in the office of the Secretary of War for consideration in civilian capacities. In Corps Area Headquarters a similar procedure has been established. The Corps Area representative of the arms or services reviews the questionnaire for consideration as commissioned officer, and the Corps Area Field Office Manager of the Civilian Personnel Division reviews it for civilian employment.

The primary function of these agencies is to furnish information to, and answer inquiries from, individuals promptly, and in the case of volunteers whose services are desired by the Army, to place them with a minimum of delay.

Educational Film Released

The Public Buildings Administration has just released an interesting film called "Action," which covers the construction of the new War Department building in the Washington, D.C., area, from the wrecking of the old structure to the completion of the new. This documentary film can be released "for educational purposes only," which means it is available to Local Sections and Student Chapters of the Society. It may be had in either 35-mm or 16-mm sound-on-film. The user must pay shipping charges in both directions, must return the film in as good condition as received, and may not charge admission. Request for its use should be made directly to the Commissioner of Public Buildings, Washington, D.C., and should include a statement that it is to be shown for educational purposes only.

Corps of Engineers to Use Engineering Firms on War Construction

It is the announced policy of the Corps of Engineers of the Army to transfer a large part of the war construction load to the private engineering firms of the country. Special forms of cost-plus-fixed-fee and lump-sum contracts have been in use for this purpose.

Since the war construction load was transferred in its entirety recently to the Corps of Engineers from the Construction Division of the Quartermaster Corps, this has become increasingly necessary. As a result of the declaration of war against the Axis powers, the war construction program is being so greatly expanded that the desirability and necessity of utilizing the services of firms in private engineering practice to handle this huge job became immediately apparent to the War Department. Maj.-Gen. Eugene Reybold, M. Am. Soc. C.E., Chief of Engineers of the Army, gave a broad picture of the relationship between the Corps and the private engineering profession in a recent address before the District of Columbia Section, which is printed in part in the "Something to Think About" section of this issue.

A statement of policy regarding the utilization of engineering firms in private practice for both design and supervision of war construction is the subject of a recent circular letter from the Office of the Chief of Engineers, addressed to all District, Division, and Area Engineers of the Corps. It states that it is the desire to avoid building up engineering and design forces in the field offices of the Corps, either in anticipation of the work to be done or to do the work on hand. The work load is expected to be intermittent and temporary. To build a large force would result in the dismemberment of established engineering firms from which such forces would have to be recruited; and the force would be subjected to dismantlement after the completion of the project, with resulting hardship to the engineers so engaged.

Exceptions to this policy are to be made when the field offices are already suitably staffed with available qualified personnel, when a showing is made that the work can be completed according to scheduled requirements; and when the field offices can give proper supervision to the work.

Except in unusual cases, the contracts for preparation of designs and specifications are to include supervision of the construction as well. Recent contracts for the design of cantonments have had an optional provision for supervision and inspection by the same firm during the construction period. It is the policy that such options be exercised and that the firm which designs the project should be retained to supervise the construction. When there are compelling reasons for not exercising the supervision and inspection option, the Corps expects to arrange at least a contract with the firm which has been engaged to prepare the plans and specifications for its consultation and advice during construction.

Contracts for engineering services are to be awarded as a result of negotiations rather than of competitive bids, with firms whose qualifications are fully acceptable to the Government. Provision has been made for agencies to receive, analyze, and evaluate information furnished by such firms. The Construction Advisory Committee has been established in the Construction Division in the Office of the Chief of Engineers, as the agency for receiving applications and records from firms to be considered on the projects costing in excess of $5,000,000. On smaller jobs, of less than $5,000,000, this is decentralized to the field offices of the Corps of Engineers. The addresses of the District and Division Offices of the Corps of Engineers were given in the February issue of Civil Engineering on page 111.

NEWS OF ENGINEERS

Personal Items About Society Members

Edgar Kennard Wilson, for many years chief engineer of the Pitometer Company, of New York City, will now serve the firm in the capacity of consulting engineer. He will be succeeded as chief engineer by E. Shaw Cole, formerly field engineer.

James C. Harding, New York City consultant, has been made commissioner of public works of Westchester County, New York.

William Edward Hamilton, manager of the construction department of Sanderson and Porter, New York City engineering and constructing firm, has been made a partner in the firm.

Rufe B. Newman, Jr., Supervising Construction Quartermaster for the U.S. War Department, Washington, D.C., has been placed in charge of construction for the government's defense program of prefabricated housing.

Francis B. Wilby, major general, Corps of Engineers, U.S. Army, has been appointed superintendent of the U.S. Military Academy at West Point. Recently General Wilby has been serving as commander for the First Corps Area of the U.S. Engineers at Boston.

Seth M. Van Loan has resigned as chief of the Philadelphia Bureau of Water in order to take a new post as engineer in charge of the Philadelphia $18,000,000 water system improvement program.

Alex Van Praag, Jr., consulting engineer of Decatur, Ill., is now serving as senior business analyst in the government requirements branch of the Office of Production Management, Washington, D.C.

L. B. Gallagher, lieutenant colonel, Corps of Engineers, U.S. Army, recently took command of the activities of the First Zone Construction Division, Office of the Quartermaster General, in Boston. Colonel Gallagher was formerly district engineer of the Boston District.

Charles O. Quade, previously associate engineer in the U.S. Engineer Office at Denison, Tex., has been named resident engineer at Karnack, Tex., on the government's $16,000,000 TNT plant.

John Roland Carr has resigned as designer for the Wyoming State Highway Department in order to accept a position with the American Bridge Company at Gary, Ind.

he has served the city of Alhambra, Calif., in a similar capacity.

J. P. WALTON, who is on the staff of the Pennsylvania Railroad, has been promoted from the position of assistant engineer of bridges to that of engineer of bridges and buildings, with headquarters in Chicago. He was formerly located in Pittsburgh, Pa.

ARNOLD H. VANDERHOOF, lieutenant, U.S. Navy, (retired), has been called to active duty and put in charge of the U.S. Hydrographic Office at Savannah, Ga. For some years Mr. Vanderhoof has maintained a consulting practice in Asheville, N.C.

WILLIAM C. BOWERS has resigned as structural designer for the Arundel Corporation and Consolidated Engineering Company, Inc., in order to accept a commission as lieutenant (jg) in the U.S. Navy. Mr. Bowers will serve as assistant civil engineer in the Civil Engineering Corps of the Navy. For the past year and a half he has been engaged on work at the naval airbase at San Juan, Puerto Rico.

JOHN EDWARD DERSHIMER, lieutenant, Corps of Engineers, U.S. Army, is now stationed at Charleston, W.Va., where he is supervising construction at Kelly field.

MALCOLM PIRNIE, New York City consultant, was elected president of the American Institute of Consulting Engineers at a meeting of the council of the Institute held on January 20. Other members of the Society elected to office in the organization were R. E. Bakenhus, vice-president; Philip W. Henry, secretary; and James Forgie, treasurer.

MARGARET G. WOOLVERTON is now traffic engineer and coordinator for the San Joaquin (California) County Safety Council, with headquarters at Stockton, Calif. She formerly held a similar position with the Traffic and Safety Commission at San Bernardino, Calif.

EDWARD C. JORDAN, lieutenant, Corps of Engineers, U.S. Army, has been assigned for temporary duty as assistant to the Constructing Quartermaster of the harbor defenses of Portland, Me.

ROBERT M. WILLIS has been promoted from the position of division engineer for the Kansas State Highway Commission to that of assistant engineer of design.

DECEASED

BION JOSEPH ARNOLD (M. '05) consulting engineer of Chicago, Ill., died at his home there on January 29, 1942, at the age of 80. Colonel Arnold worked on a plan for the electrification of Grand Central Terminal in New York, and this project was carried out while he was a member of New York's Electric Traction Commission. From 1907 until his death he was chairman of the Board of Supervising Engineers for Chicago Transit Lines, and he has served as consultant on traction matters for many cities in this country and Canada. He was past-president and honorary member of the American Institute of Electrical Engineers and past-president of the Western Society of Engineers. In 1929 he received the Washington Award ". . . for pioneering work in the engineering and economics of electric transportation."

WILLIAM JAMES BACKES (M. '12) consulting engineer for the Boston and Maine Railroad, Boston, Mass., died suddenly on January 20, 1942. Mr. Backes, who was 62, had been with the Boston and Maine since 1926. Before that (1906 to 1913) he was chief engineer of the Central New England Railroad, and from 1913 to 1923 was, successively, engineer of maintenance of way and assistant general manager for the New York, New Haven and Hartford Railroad.

JAMES SINGLETON CLAY (Assoc. M. '19) senior highway bridge engineer for the Public Roads Administration, Washington, D.C., died in Philadelphia, Pa., on January 2, 1942. He was 52. Mr. Clay entered the government service in 1917 and was connected with the Public Roads Administration until his death, having served in the district offices at Birmingham, Ala., and Troy, N.Y. Earlier in his career he was in the Bridge Department of the City of Philadelphia.

GEORGE WARREN CUTTING, JR. (Assoc. M. '10) civil engineer of Boston, Mass., died at his home in Weston, Mass., on February 4, 1942. Mr. Cutting, who was 64, had maintained his consulting practice for many years. He had served on the Massachusetts State Board of Fire Underwriters and was one of the engineers on the construction of the Corregidor fortress in the Philippines.

HARRY JOHNSON DEUTSCHBEIN (Assoc. M. '13) president of H. J. Deutschbein Company, Inc., New York, N.Y., died on February 8, 1942, at the age of 62. At one time Mr. Deutschbein was deputy city engineer of Albany and superintendent of that city's water system. In 1909 he joined the Foundation Company of New York, and was its president from 1925 to 1929, when he founded his own corporation. Among the projects on which he worked was the caisson foundation for the West Side extension of the New York Central Railroad.

SAMUEL DOUGLASS DODGE (Assoc. M. '07) retired engineer of Suffern, N.Y., died on December 11, 1941, at the age of 71. From 1895 to 1906 Mr. Dodge was with the Metropolitan Water and Sewerage Board of Massachusetts. Later he was assistant engineer for the New York City Board of Water Supply, with headquarters at Cornwall-on-Hudson, N.Y.

FRED EUGENE FOSS (M. '03) professor emeritus of civil engineering at Cooper Union, died at Bethesda, Md., on January 18, 1942. He was 79. Professor Foss was head of the civil engineering department at Cooper Union from 1909 to 1938, and was responsible for the creation and development of the institution's materials testing and hydraulic laboratories. Earlier in his career he had held professorial posts at Pennsylvania State College and Carnegie Institute of Technology. Coincident with his other duties, he served for eighteen years as civil engineering examiner for the Municipal Civil Service Commission of New York.

MARTIN HUGHES GERRY, JR. (M. '02) consulting engineer of San Francisco, Calif., died in that city on December 30, 1941, at the age of 81. From 1898 to 1912 Mr. Gerry was chief engineer and general manager of the Missouri River Power Company, and from the latter year to 1917 maintained a consulting practice at Helena, Mont. During the war he was Federal Fuel Administrator for Montana, resuming his practice in Montana after the war. From 1924 on he maintained a private practice in San Francisco, Calif.

ARTHUR FRANKLIN GORDON (M. '24) senior highway bridge engineer for the Public Roads Administration, Washington, D.C., died suddenly on January 29, 1942. Mr. Gordon, who was 66, had been with the Public Roads Administration since 1919. His earlier affiliations include the McClintic-Marshall Construction Company, the Pittsburgh Bridge and Iron Company, and the American Bridge Company. At one time also (1912 to 1916) he was bridge designer for the City of Pittsburgh.

BURR POWELL HARRISON (M. '11) since 1930 on the staff of the Public Roads Administration, Washington, D.C., died on January 21, 1942, at the age of 65. Earlier in his career he was first assistant engineer for the Maryland State Road Commission and assistant engineer for the Virginia State Highway Commission. At one time, also, he maintained a consulting practice in Baltimore.

GEORGE PRINCE HAWLEY (M. '14) of Los Angeles, Calif., died at Santa Monica, Calif., on November 26, 1941. Until his retirement in 1937 Mr. Hawley was for some years with the Montreal (Canada) Light, Heat, and Power Company. Earlier in his career he had been resident engineer for the Cedars Rapid Manufacturing and Power Company, Cedars, Canada, and at one time maintained a consulting practice at De Pere, Wis.

JOSEPH CHURCHILL HILTON (Assoc. M. '07) project engineer since 1939 for the Public Works Administration in the construction of the Belt Parkway in Brooklyn, N.Y., died at New Rochelle, N.Y., on January 29, 1942. He was 69. Mr. Hilton was assistant superintendent of construction in the building of early New York subways and of the Pennsylvania Railroad tunnels in New York. From 1926 to 1936 he supervised the construction of numerous South American projects, including La Quiebra railroad tunnel in Colombia and the Puente Negro Dam near Santiago, Chile.

CHARLES HANFORD KENDALL (M. '07) field engineer for District 6 of the Texas State Highway Department, Pecos, Tex., died on December 9, 1941. Mr. Kendall, who was 69, spent his early career in railroad work in this country and the Philippines. Later he was with the Utah State Highway Commission and, for some years

past, has been with the Texas State Highway Department in varying capacities.

Lloyd Tevis McAfee (M. '30) utilities engineer, Public Utilities Commission, City and County of San Francisco (Calif.), died in San Francisco on January 1, 1942. Mr. McAfee, who had been in the San Francisco engineering department since 1909, built the city's two principal tunnels (Stockton St. and Twin Peaks). From 1918 on he was connected with the Hetch Hetchy development, and in 1930 became the city's first assistant city engineer with direct supervision over all Hetch Hetchy work. During the building of the Golden Gate International Exposition, he had charge of permanent construction on the island.

Frank Bierce Maltby (M. '95) retired consultant of Denver, Colo., died in that city on December 22, 1941, at the age of 80. He served as principal assistant in charge of dredging to John F. Stevens during the construction of the Panama Canal and, later, was construction engineer for Day and Zimmermann, of Philadelphia. He was engaged in engineering and consulting work on the development of many harbors in the United States and abroad, including one in Liberia for the Firestone Company. Colonel Maltby was commissioned an Engineer Officer during the World War, and served as section engineer at St. Nazaire, France, for some time, receiving the Legion of Honor award from the French government for his services.

Earle Dawson Parker (M. '30) district engineer for the Lane Construction Corporation, of Meriden, Conn., died on January 9, 1942, as the result of injuries received in an automobile accident a few days earlier. He was 53. From 1913 to 1922 Mr. Parker was with the New York State Highway Commission—after 1914 as assistant engineer in charge of construction. He had been with the Lane Construction Corporation since 1922.

Albert Haskell Rhett (Assoc. M.'10) of Summit, N.J., died on January 2, 1942. For some years Mr. Rhett was in the engineering employ of Toch Brothers, of New York City. Later (1935 to 1940) he was selling agent for the Porete Manufacturing Company, of Arlington, N.J.

John Joseph Sweeney (Assoc. M. '22) senior inspector of construction for the U.S. Department of Public Works at the Philadelphia Navy Yard, died at his home at Ardmore, Pa., on January 6, 1942. For seventeen years Mr. Sweeney taught highway engineering at Villanova College, from which he was graduated in 1912.

John Albert Vogleson (M. '08) retired engineer of Philadelphia, Pa., died on January 16, 1942, at the age of 70. Major Vogleson's career included sewer and water-works construction in the Philippines and a period with the New York Department of Water Supply. From 1907 to 1910 he was in the Philadelphia Bureau of Water Supply, and from the latter to 1922 chief of the Philadelphia Bureau of Health. He was chief engineer of the Philadelphia Bureau of Engineering from 1924 to 1928, and engineer for Day and Zimmermann, of Philadelphia, from 1928 to 1941. During the war he served with the rank of major in the Sanitary Corps of the U.S. Army.

Herbert Lester Williams (M. '38) senior engineer, U.S. Engineer Department, New Orleans, La., died in that city on January 9, 1942. He was 40. Mr. Williams had been with the U.S. Engineer Department since 1928—from 1935 on as civil engineer for the 2d District at New Orleans, assisting the chief of the Engineering Division. Earlier in his career (1926 to 1928) Mr. Williams was with the Alabama State Docks Commission.

Albert Joseph Wise (M. '12) civil and consulting engineer of Houston, Tex., died on February 3, 1942, at the age of 70. Mr. Wise was for many years a member of the Houston firm of Howe and Wise, which originated two nationally used methods of highway construction—the water jetting of highway embankments to strengthen them without the long process of natural settling and the use of a lip curb in swampy regions to block the washing of highway embankments. Mr. Wise had served as resident state highway engineer at Houston and had, also, been county engineer of Harris County (Tex.).

Arthur Henry Pratt (M. '13) chief hydraulic engineer of the Public Service Commission of New York, died at South Orange, N.J., on February 1, 1942. He was 67. Before joining the Public Service Commission about ten years ago, Mr. Pratt was consulting engineer for the North Jersey District Water Supply Commission. He had also acted as consultant for various north Jersey municipalities. During the war he served, successively, as captain and major of Engineers with the A.E.F. in France.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From January 10 to February 9, 1942, Inclusive

Additions to Membership

Adams, James Otis (Jun. '41), Junior Engr., State Div. of Water Resources, 506 New England Bldg., Topeka (Res., Eureka), Kans.

Alexander, William Anthony (Jun. '41), Asst. Civ. Engr., U.S. Engr. Dept., Box 1431, Palm Springs, Calif.

Anderson, Earl Jay (Jun. '41), Structural Draftsman, H. J. Brunnier, 612 Sharon Bldg., San Francisco, Calif.

Baker, Woodrow Wilson (Jun. '41), Junior Engr. (Civ.), War Dept., U.S. Engrs., Custom House, Nashville, Tenn.

Bartels, William Rudolf (M. '40), Senior Highway Bridge Engr., Div. of Highways, Dept. of Public Works, Territorial Office Bldg. (Res., 1305 Wilhelmina Rise), Honolulu, Hawaii.

Barth, Charles Henry, Jr. (M. '41), Lt. Col., Corps of Engrs., U.S. Army, Special Eng. Div., The Panama Canal, Diablo Heights, Canal Zone.

Bennett, Sheldon Appleby (Jun. '41), Junior Engr., U.S. Bureau of Reclamation, Box 2039, Phoenix, Ariz.

Bishop, Paul Lepage (Assoc. M. '42), Engr., The Kaiser Co., Navy Yard, Mare Island (Res., 1731 Alabama, Vallejo), Calif.

Blower, Howard Edward (Jun. '41), Junior Engr., East Bay Municipal Utility Dist., 512 Seventeenth St., Oakland (Res., 672 Thirtieth St., Richmond), Calif.

Bly, Ernest Richard (Jun. '41), Area Engr., Constr. Dept., E. I. du Pont de Nemours & Co., Inc., Deepwater, N.J. (Res., 907 West St., Wilmington, Del.)

Bowden, Adrain C. W. (Jun. '41), Junior Civ. Engr., Humble Oil & Refining Co. (Res., Y.M.C.A.), Houston, Tex.

Brees, Glen Edward (Jun. '41), State Hydrographer, State Eng. Dept., 20 Capitol Bldg. (Res., 1180 Pennsylvania St.), Denver, Colo.

Brown, Charles Franklin (Jun. '41), 2d Lt., 65th Coast Artillery (Anti-aircraft), U.S. Army, Headquarters 1st Battalion, Inglewood, Calif.

Burk, William Richard, Jr. (Jun. '41), Engr., Lone Star Defense Corp., Texarkana, Tex.

Burnham, Raymond (M. '42), Chf. Production Engr., Shell and Bomb Loading Div., Day & Zimmerman, Inc., Iowa Ordnance Plant, Burlington, Iowa. (Res., 930 East 45th St., Chicago, Ill.)

Buxton, Edmund Ross, Jr. (Jun. '41), Asst. Engr., Walsh-Driscoll Constr. Co., Army Post Office 803, Trinidad.

Case, Douglas (Jun. '41), With Spiral Pipe and Formed Products Sales, The Am. Rolling Mill Co., 703 Curtis (Res., 211 North Sutphin), Middletown, Ohio.

Cash, Mitchell (Jun. '41), Ensign, U.S.N.R., Industrial Dept., Navy Yard (Res., 4723 Cedar Ave.), Philadelphia, Pa.

Cavaliere, Alfonse Maria (Jun. '42), Senior Eng. Aid Draftsman, State Highway Dept., 165 Capitol Ave., Hartford (Res., 477 Chapel St., New Haven), Conn.

Chambers, Harold Joseph Ashbridge (M. '42), Chf. Engr., Hamilton Bridge Co., Ltd., 231 Bay St., North, Hamilton, Ont., Canada.

Clarke, John Leslie, Jr. (Jun. '41), Junior Engr., Alabama Ordnance Works, Sylacauga, Ala.

Compton, Kenneth Lyle (Jun. '41), Asst. Engr., U.S. Engr. Dept., Dist. Office, Army Post Office 803, Trinidad.

Cook, Paul Meredith (Jun. '41), A.I.D. Insp., Royal Canadian Air Force, 13th (Technical) Detachment (Res., 6658 Laburnum St.), Vancouver, B.C., Canada.

Cosens, Kenneth Wayne (Jun. '42), Instr., Dept. of Civ. Eng., Michigan State College, East Lansing, Mich.

Cotrim, John Reginald (Jun. '41), Asst. Hydr. Engr., Cia. Auxiliar de Empresas, Eletricas Brasileiras, Caixa Postal 883, Rio de Janeiro, Brazil.

Curtis, Carl Lamar (Jun. '41), Production Eng. Trainee, Lockheed Aircraft Corp. (Res., 123 East Cedar Ave.), Burbank, Calif.

Dahl, Norman Christian (Jun. '41), 742 North 74th St., Seattle, Wash.

Deems, Nyal Wilbert (Jun. '41), Ensign, A-V (S), U.S.N.R., A and R Dept., Naval Air Station, San Juan, Puerto Rico.

D'Errico, Thomas Richard (Jun. '42), With Parkersburg Rig & Reel Co., Depot (Res., 1900 Seventh St.), Parkersburg, W.Va.

DILLON, JACK G. (Jun. '41), Junior Hydr. Engr., Water Resources Branch, U.S. Geological Survey, 1100 Washington Bldg., Tacoma, Wash.

DEVALLE, JOEL WELBORN (Jun. '41), Junior Structural Engr., TVA, 200 Arnstein Bldg. (Res., 1808 White Ave., Apt. 2), Knoxville, Tenn.

DIETER, PHILIPP GEORGE, JR. (Jun. '41), Junior Engr. (Civ.), U.S. Engr. Dept., Santa Fe Bldg. (Res., 1819 Sealy), Galveston, Tex.

DOYLE, JAMES LAFAYETTE (Jun. '41), Junior Engr., SCS, Old Post Office Bldg. (Res., 513½ West 6th St.), Amarillo, Tex.

EICHER, JAMES MORRELL (Jun. '42), Loop Engr. Bethlehem Steel Corp., Rankin Works, Rankin (Res., 3009 Atcheson Ave., McKeesport), Pa.

EPSTEIN, OSCAR (Jun. '41), Field Engr., L. C. Roberts Co., Inc., New York, N.Y. (Res., 5745 North Fairhill St., Philadelphia, Pa.)

EUSTROM, HARVEY HENRY (Assoc. M. '42), Maj., Corps of Engrs., U.S. Army, Iowa Ordnance Plant, Burlington, Iowa.

FIELDS, RICHARD CLORE (Jun. '41), Draftsman, Am. Bridge Co., Park Rd., Ambridge, Pa.

FITCH, LEWIS WILLIAM (Assoc. M. '41), Project Engr., State Highway Dept., Box 542, St. Ignace, Mich.

FOGG, CHARLES HARLEY (Assoc. M. '42), Road Designer, State Highway Dept., State House Annex (Res., 16 Chapel St.), Concord, N.H.

FOSTER, LEO JOSEPH (M. '41), Constr. Engr., U.S. Bureau of Reclamation, Bin 151, Yuma, Ariz.

FUHR, WALTER ERVIN (Jun. '42), Rodman, Office of Div. Engr., C.M.St.P. & P.R.R. (Res., 215 North 9th St.), Miles City, Mont.

GALLOWAY, WILLIAM ARNOLD (Jun. '42), Junior Civ. Engr., Maps and Surveys Div., TVA, Box 272, Sevierville, Tenn.

GARRATT, DAVID LYMAN (Jun. '42), Structural Draftsman, Am. Bridge Co., Elmira Heights (Res., 219 West 1st St., Elmira), N.Y.

GASTON, SAMUEL (Assoc. M. '41), Area Insp., Pacific Locks Area, Municipal Eng. Div., The Panama Canal, Field Office, S.I.P. 7, Pedro Miguel, Canal Zone.

GEIGER, LAWTON DELANY (Jun. '42), 2d Lt., Corps of Engrs., U.S. Army, Louisiana Ordnance Plant, Minden, La.

GENTRY, BRUCE AGAR (Jun. '41), Associate Engr., Dist. Office, U.S. Engr. Dept., Young Bldg., Honolulu, Hawaii.

GIBBS, FREDERICK SCOTT (Assoc. M. '42), San. Engr., Wallace & Tiernan Co., Inc., 346A Newbury St., Boston, Mass.

GLENDINNING, ALBERT WILLIAM (Assoc. M. '41), Project Supt., U.S. Forest Service, Alturas, Calif.

GOODWIN, JAMES FREDERICK (Jun. '42), Structural Designer, Republic Steel Corp., Mineville, N.Y.

GORDON, GLENN COATES (Jun. '41), Draftsman, Wm. J. Moran, 1011 South Fremont (Res., 239 South Atlantic Blvd.), Alhambra, Calif.

GRAHAM, JAMES DAVID (Jun. '41), 2d Lt., Corps of Engrs., U.S. Army, Chf., Labor Relations, U.S. Engrs., 900 Custom House, Philadelphia, Pa.

GRISWOLD, WILLIAM SHERIDAN (Jun. '41), Field Engr., Planning Survey, State Highway Dept., 1701 West Jackson (Res., 1325 West Monroe), Phoenix, Ariz.

GUSTAFSON, WILLIAM ARTHUR (Jun. '41), Eng. Draftsman, Am. Shipbuilding Co., West 54th St., Cleveland (Res., 17001 Lakewood Heights Blvd., Lakewood), Ohio.

HALE, DAVID PHILLIPS (Jun. '41), Junior Engr., U.S. Bureau of Reclamation, Box 2082, Abilene, Tex.

HARIG, FRANK EUGENE (Jun. '41), Field Engr., J. & F. Harig Co., 1425 Queen City Ave., Cincinnati, Ohio.

HAUSWALD, ARTHUR CHARLES (Jun. '41), Bridge Draftsman, A.T. & S.F. R.R., 80 East Jackson Blvd., Chicago (Res., 1014 Belleforte Ave., Oak Park), Ill.

HEALY, JOHN HAMILTON (Jun. '42), Draftsman, Arthur G. McKee & Co., 2300 Chester (Res., 2200 Prospect), Cleveland, Ohio.

HENDRICKSON, KARL NEWCOMB (Jun. '41), Ensign, CEC-V(S), U.S.N.R., Navy Yard, Portsmouth, N.H.

HENRY, KENNETH DEAN (Jun. '41), Junior Engr. (Civ.), U.S. Engr. Dept., 10 East 17th, Kansas City, Mo.

HULSBOS, CORNIE LEONARD (Jun. '42), Draftsman, Am. Bridge Co. (Res., 722 Park Rd.), Ambridge, Pa.

ISEMINGER, HAROLD FRANCIS (Jun. '41), Draftsman, Am. Bridge Co. (Res., 347 Gardner Ave.), Trenton, N.J.

JOHNSON, NORMAN PERRY (Jun. '41), Junior Engr., War Dept., U.S. Engr. Dept., 613 Federal Bldg. (Res., 622 Marquette Drive), Detroit, Mich.

KEESECKER, VICTOR CARL (Jun. '41), Junior Engr., U.S. Engrs., War Dept., Box 875, Freeport, Tex.

KERBER, WILLIAM CONRAD, JR. (Jun. '41), Ensign, U.S.N.R., Brewster Aeronautics Corp., Newark, N.J. (Res., 130 East Plumstead Ave., Lansdowne, Pa.)

KIRCHMAN, MILTON FREDERICK (Assoc. M. '42), With Burns & Roe, Inc., 233 Broadway, New York (Res., 233 A Brooklyn Ave., Brooklyn), N.Y.

KLINE, EUGENE ROLLIE (Jun. '41), 2d Lt., Company D, 5th Engrs., U.S. Army, Army Post Office 810, Iceland.

KUMM, ARTHUR WILLIAM FREDERICK, JR. (Jun. '41), Asst. Plant Engr., Vilter Mfg. Co., 2217 South 1st St. (Res., 1532 North 20th St.), Milwaukee, Wis.

KURTZ, CHARLES HENRY, JR. (Jun. '41), Field Engr., Columbia Chemical Div., Pittsburgh Plate Glass Co., Barberton (Res., 2189 Fifteenth St., S.W., Akron), Ohio.

LOFGREN, BENJAMIN ELDER (Jun. '42), 79 South 12th East, Salt Lake City, Utah.

LUHRS, ROBERT HENRY (Jun. '41), Junior Engr., U.S. Engrs., War Dept., Oscoda, Mich.

LYMAN, ROBERT JOSEPH (Jun. '42), Box 183, Albuquerque, N.Mex.

MCDONALD, LEWIS (M. '42), Asst. to Vice-Pres., Chicago Bridge & Iron Co., 332 South Michigan Ave., Chicago, Ill.

MCQUAID, DANIEL JOSEPH, JR. (Jun. '41), Junior Engr., U.S. Bureau of Reclamation, New Customhouse (Res., 1565 Milwaukee St.), Denver, Colo.

MARKEY, WILLIAM FLETCHER (Jun. '41), 2d Lt., Infantry Reserve, U.S. Army, 701 Tractor-drawn Battalion (H), Fort Knox, Ky. (Res., 1602 Newton St., Akron, Ohio.)

MARTINI, ARIGO JOHN PAUL (Jun. '42), Civ. Engr., Scrufari Constr. Co., 825 Fifteenth St. (Res., 825 Seventeenth St.), Niagara Falls, N.Y.

MEISTERLIN, CARL SVERRE (Assoc. M. '41), Designer, Olsen, Deitrick, Carr and J. E. Greiner Co., Marine Air Base, Cherry Point (Res., 89 Metcalf St., New Bern), N.C.

MITCHELL, FRANCIS EUGENE (Jun. '41), Instr., Dept. of Civ. Eng., Univ. of Arkansas, Fayetteville, Ark.

MITTLEMAN, GEORGE (Jun. '41), Junior Civ. Engr., TVA, Box 485, Watts Bar Dam, Tenn.

MONTGOMERY, JAMES MCKEE (M. '42), (J. M. Montgomery & Co.), 306 West 3d St., Los Angeles, Calif.

MYOTT, ERME BURTTLE (M. '42), Senior Engr., Fay, Spofford & Thorndike, 11 Beacon St., Boston (Res., 6 Virginia Rd., Reading), Mass.

NARVER, DAVID LEE, JR. (Jun. '42), Box 1333, Stanford University, Calif.

NESS, HOWARD (Jun. '41), Stress Analyst, Curtiss-Wright Corp., Plant 2 (Res., 619 West Delavan Ave.), Buffalo, N.Y.

NECHWORT, GEORGE FRANKLYN (Jun. '41), Eng. Aide, The Panama Canal, Care, T. V. McGee, Box 359, Diablo Heights, Canal Zone.

NYSTROM, ROBERT FREDERICK (Jun. '41), Instrumentman, Foley Brothers, Inc.-Walbridge, Aldinger Co., Twin Cities Ordnance Plant, New Brighton (Res., 2626 Elliot Ave., South, Minneapolis), Minn.

TOTAL MEMBERSHIP AS OF FEBRUARY 9, 1942

Members	5,743
Associate Members	6,826
Corporate Members	12,569
Honorary Members	37
Juniors	4,868
Affiliates	68
Fellows	1
Total	17,543

PATHMAN, WILLIAM JAY (Jun. '41), Junior Engr., U.S. Engr. Office, War Dept., Wright Bldg. (Res., 1501 South Baltimore St.), Tulsa, Okla.

PERRY, JOSEPH ELMER (Jun. '41), 305 North 8th, Pawnee, Okla.

PETERSEN, JOHN WILLIAM (Jun. '41), Junior Engr., War Dept., Ninth and I (Res., 1920 H St.), Sacramento, Calif.

PETERSON, LEE RICHARD (Jun. '41), Junior Hydr. Engr., U.S. Geological Survey, 404 Eng. Experiment Station, Ohio State Univ. (Res., 2045 North 4th St.), Columbus, Ohio.

POND, WENDELL FRANCIS (Jun. '41), Junior Bridge Engr., State Div. of Highways, 1120 N St. (Res., 2448 Portola Way), Sacramento, Calif.

REYNOLDS, HAROLD RUTLEDGE, JR. (Jun. '41), Civ. Engr. (Structural Draftsman and Designer), Frederic R. Harris, Inc., 27 William St., New York (Res., 135 Eighty-third St., Brooklyn), N.Y.

RICKER, PAUL HARDING (Jun. '41), Engr., Walsh-Driscoll Constr. Co., Army Post Office 803, Port of Spain, Trinidad.

ROSSI, FRANK JOSEPH (M. '42), City Engr., 616 Tenth St., (Res., 309 El Rio), Modesto, Calif.

SAMS, ALLEN LEVERNE (Jun. '41), Chainman, Eng. Dept., I.C. R.R., 613 North Madison, Clinton, Ill.

SCHECKEL, WILLIAM BOULTON (Assoc. M. '42), Structural Engr., United Engrs. & Constructors, 1401 Arch St., Philadelphia (Res., 715 Kenmare Rd., Bala-Cynwyd), Pa.

STAMM, PAUL QUENTIN (Jun. '41), Chf. Engr., Cauldwell-Wingate Co., 8600 Southfield (Res., 2250 West Grand Blvd.), Detroit, Mich.

STELLY, LEO ALLAN (Jun. '41), Junior Engr. (Civ.), U.S. Engr. Office, 605 Federal Bldg. (Res., 16569 Wark Ave.), Detroit, Mich.

STOCKTON, HERBERT REECE (Jun. '41), Junior Hydr. Engr., U.S. Geological Survey, Box 138 (Res., 1101 Oak St.), Rolla, Mo.

SUNBURY, ROGER DWIGHT (Jun. '41), Field Engr., U.S. Steel Export Co., Box D, Balboa, Canal Zone.

TAMANINI, FLORY JOHN (Jun. '41), Junior Engr., U.S. Engr. Board, War Dept., Fort Belvoir (Res., 195 Yale Drive, Alexandria), Va.

THAYER, EDWIN SWEET (Jun. '41), Field Engr., John W. Harris Associates, Inc., Seneca Ordnance Depot, Kendai (Res., 180 Washington St., Geneva), N.Y.

TOWER, KENNETH GERALD (Jun. '41), Associate Engr., U.S. Engrs., War Dept., 209 Pittock Block (Res., 3147 North East 32d Ave.), Portland, Ore.

WALKER, DAN (Jun. '41), Junior Engr., Alabama Ordnance Works, Sylacauga, Ala.

WALLACE, HENRY NEWMAN, JR. (Jun. '41), Junior Naval Archt., U.S. Maritime Comm., Mare Island (Res., 3932 Lakeshore Ave., Oakland), Calif.

WEISS, FREDERICK LUDWIG (Assoc. M. '41), Asst. Constr. Engr., TVA, Fort Loudoun Dam, Lenoir City, Tenn.

WELLER, WILLIAM LEE (Jun. '41), 3819 Echodale Ave., Baltimore, Md.

WHITACRE, HORACE J., JR. (Jun. '41), Asst. Engr., Henry Mill & Timber Co., Box 1133 (Res., 2817 North Washington St.), Tacoma, Wash.

WHITE, THORWALD BARTIMUS (Assoc. M. '42), Asst. Dist. Highway Engr., State Highway Dept., Roswell, N.Mex.

WILKES, WALTER JACKSON (Jun. '41), Junior Engr. (Naval Archt.), U.S.N., Constitution Ave., Washington, D.C. (Res., 7426 Piney Branch Rd., Takoma Park, Md.)

WILLARD, JAMES EDWARD (Assoc. M. '42), (Johnson & Willard), 422 Front St., Knoxville, Tenn.

WOLF, WALTER WORBEL (Jun. '41), Insp., Consoer, Townsend & Quinlan, Kansas Ordnance Plant (Res., 1330 Corning), Parsons, Kans.

WOLTERSDORF, DONALD BYRON (Jun. '41), Junior Agri. Engr., SCS, Box 472, Buffalo, Wyo.

WONG, ALFRED JACK QUON (Jun. '41), Junior Civ., Engr., U.S. Engrs., Young Hotel (Res., 3701 Waialae Ave.), Honolulu, Hawaii.

WHITNEY, WILLIAM JAMES (Jun. '41), Lt., Air Corps, U.S. Army, Air Corps Advanced Flying School, Foster Field, Victoria, Tex.

YARABECK, ROBERT ROLAND (Jun. '42), Junior Public Health Engr., U.S. Public Health Service, Bay County Health Dept., Panama City, Fla.

MEMBERSHIP TRANSFERS

BARBER, JOSEPH FRANKLIN (Jun. '32; Assoc. M. '41), Engr., State Highway Testing Labora-

tory, Ohio State Univ. Campus (Res., 91 West Lakeview Ave.), Columbus, Ohio.

Brescia, Ralph Nicholas (Jun. '40; Assoc. M. '42), Asst. Engr., Administrative Staff, Div. of Operations, Federal Works Agency, WPA, 70 Columbus Ave. (Res., 1741 Pilgrim Ave.), New York, N.Y.

Cartelli, Vincent Robert (Jun. '36; Assoc. M. '22), Asst. Engr., U.S. Engr. Office, War Dept., 120 Wall St. (Res., 173 East 165th St.), New York, N.Y.

Curtis, Ira Nankervis (Jun. '31; Assoc. M. '41), Lt., CEC, U.S.N., 2123 Adams Blvd., Saginaw, Mich.

Dillingham, Marion Alfred (Jun. '30; Assoc. M. '41), Engr., U.S. Engr. Office, Post Office Bldg., Galveston, Tex.

Farmer, Sidney French (Jun. '30; Assoc. M, '41), Asst. Engr., U.S. Engr. Office, Federal Bldg. (Res., 1251 Fourth St.), Louisville, Ky.

Fields, Kenneth E. (Jun. '38; Assoc. M. '42), Capt., Corps of Engrs., U.S. Army, Box 80, Vicksburg, Miss.

Folk, Samuel Byron (Assoc. M. '26; M. '42), Associate Prof. of Mechanics, Ohio State Univ., Columbus, Ohio.

Gildea, Albert Patrick (Jun. '34; Assoc. M. '41), Associate Hydr. Engr., U.S. Engr. Office, 751 South Figueroa St., Los Angeles (Res., 630 West Dryden St., Glendale), Calif.

Glynn, Frederick Stanley, Jr. (Jun. '38; Assoc. M. '42), Office Engr., Stone & Webster Eng. Corp., Reeves and Clay Ave., Norfolk (Res., 1127 Seaboard Ave., South Norfolk), Va.

Liddle, George Frederick (Assoc. M. '29; M. '42), City Supt. and Engr., City Hall, Muskegon Heights, Mich.

Miller, Henry Stevenson (Assoc. M. '26; M. '42), Senior Civ. Engr., Sewers and Paving Div., Board of Public Service, 300 City Hall (Res., 2349 South 39th St.), St. Louis, Mo.

Moore, William Wallace (Jun. '34; Assoc. M. '42), (Dames & Moore), 461 Russ Bldg., San Francisco, Calif.

Peterson, Dean Freeman (Jun. '35; Assoc. M. '42), Asst. Engr., Sanderson & Porter, Pine Bluff Arsenal (Res., 1107 West 16th Ave.), Pine Bluff, Ark.

Prater, Herbert E. (Jun. '31; Assoc. M. '42), Capt., Corps of Engrs., U.S. Army, 529 Custom House (Res., 169 Mohawk St.), Mobile, Ala.

Sobieralski, Valentine Ralph (Jun. '31; Assoc. M. '42), Deck Officer, U. S. Coast and Geodetic Survey, Washington, D.C.

Stoller, Mandell Dudley (Jun. '34; Assoc. M. '41), Capt., Corps of Engrs., U.S. Army, 805th Engr. Battalion, Aviation (Separate), Albrook Field, Canal Zone.

Studdert, William Walton (Jun. '30; Assoc. M. '31; M. '42), Lt., CEC-V(S), U.S.N.R., Marine Barracks, New River, N.C.

Suehrstedt, Henry George (Jun. '23; Assoc. M. '27; M. '42), Res. Engr., E. B. Badger & Sons Co. (Res., 909 Fifth St.), Sandusky, Ohio.

White, Robert Emelin (Jun. '37; Assoc. M. '42), Civ. Engr., Spencer, White & Prentis, Inc., 10 East 40th St. (Res., 170 East 77th St.), New York, N.Y.

Whitman, Worsham Carroll (Jun. '37; Assoc. M. '41), Office Engr., State Highway Dept., Box 3067, Dallas, Tex.

Williams, Tudor Rosser (Assoc. M. '29; M. '42), Cons. Engr., 522 Scranton Life Bldg., Scranton, Pa.

Wurts, William Alfred DuBois (Assoc. M. '30; M. '42), Asst. City Engr., Dept. of Eng., Municipal Bldg., Hartford, Conn.

Reinstatements

Dukes, William Weaver, Jun., reinstated Jan. 21, 1942.

Eckert, Otto Elis, M., reinstated Jan. 24, 1942.

Frank, Aaron Herbert, Assoc. M., reinstated Jan. 16, 1942.

Howard, William James, Assoc. M., reinstated Jan. 13, 1942.

Leigh, Word, M., reinstated Jan. 29, 1942.

Woods, Edwin Marechal, Assoc. M., reinstated Jan. 23, 1942.

Woodward, Harold Stone, Assoc. M., reinstated Feb. 2, 1942.

Resignations

Beauregard, Armand Toutant, Assoc. M., resigned Dec. 31, 1941.

Bennett, Harry, M., resigned Jan. 31, 1942.

Braunstein, Leonard, Jun., resigned Jan. 28, 1942.

Carrick, Richard Scott, Assoc. M., resigned Jan. 31, 1942.

Fernald, Gordon Hildreth, Assoc. M., resigned Jan. 31, 1942.

Harrison, Simon Henry, M., resigned Dec. 31, 1941.

Jones, George Wiley, Assoc. M., resigned Dec. 31, 1941.

Kistler, Homer King, M., resigned Jan. 31, 1942.

Marchetti, Aldo, Jun., resigned Jan. 16, 1942.

Pierce, Henry Tyler, Assoc. M., resigned Dec. 31, 1941.

Place, Arthur Harrington, M., resigned Jan. 31, 1942.

Reeder, William Chester, M., resigned Dec. 31, 1941.

Romeo, Anthony Frank, Jun., resigned Jan. 31, 1942.

Russell, Howard Wootten, Assoc. M., resigned Dec. 31, 1941.

Shah, Dhirajlal Somchand, Assoc. M., resigned Jan. 31, 1942.

Shea, Chelius Hazel, Assoc. M., resigned Jan. 31, 1942.

Smith, Frederik Egid, Assoc. M., resigned Feb. 2, 1942.

Taplin, Abraham, Jun., resigned Dec. 31, 1941.

Wilson, Henry Everett, Assoc. M., resigned Jan. 31, 1942.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment from Members to Board of Direction

March 1, 1942 — Number 3

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in Civil Engineering *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

Minimum Requirements for Admission

Grade	General Requirement	Age	Length of Active Practice	Responsible Charge of Work
Member	Qualified to design as well as to direct important work	35 years	12 years	5 years RCM*
Associate Member	Qualified to direct work	27 years	8 years	1 year RCA*
Junior	Qualified for sub-professional work	20 years	4 years	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years	5 years RCM*

* In the following list RCA (responsible charge—Associate Member standard) denotes years of responsible charge of work as principal or subordinate, and RCM (responsible charge—Member standard) denotes years of responsible charge of IMPORTANT work, i. e., work of considerable magnitude or considerable complexity.

Applying for Member

Berrigan, Thomas Augustine, Westwood, Mass. (Age 46) (Claims RCM 22.1) June 1935 to date with Metropolitan Dist. Comm., Boston, in responsible charge of design and construction of North Metropolitan relief sewer.

Burke, Walter Anthony, Jr. (Assoc. M.), Louisville, Ky. (Age 38) (Claims RCA 3.1 RCM 5.2) Jan. 1941 to date Lt. (jg) CEC, U.S.N.R.; 1928 to 1936 with Thomas Crimmins Constr. Co., New York City, as Transitman, Estimator, Field Engr., Office Asst. Engr., Field Supt., Constr. Engr., etc.; in the interim on military research, etc.

Christian, William Earl, New Brunswick, N.J. (Age 44) (Claims RCA 11.1 RCM 9.3) Oct. 1937 to Jan. 1938 Engr. Estimator, and April 1941 to date Constr. Engr., Standard Bitulithic Co.; in the interim Constr. Engr., Highway Improvement and Repair Co., Engr., Serafine Constr. Co., Inc., and Associate Engr., U.S. Engrs. Dist. Office, Norfolk, Va.

Emigh, William Chester (Assoc. M.), Coatesville, Pa. (Age 53) (Claims RCA 7.7 RCM 18.2) April 1931 to date City Engr.,C oatesville, Pa., in responsible charge of all municipal work.

Gerhardt, Louis Mathew, Rochester, N.Y. (Age 42) (Claims RCM 10.7) 1930 to 1931 Constr. Engr. and Designer, and 1934 to date Engr., Eastman Kodak Co., Rochester, N.Y.; in the interim Asst. Engr., Office of Quartermaster General, Washington, D.C.

Hegarty, Thomas Edward, Somerville, Mass. (Age 37) (Claims RCA 4.5 RCM 9.4) Jan. 1938 to date City Engr., Somerville, Mass.; previously Sales Engr. and Mgr., Waldo Bros. Co., Boston.

Hill, Bancroft, Baltimore, Md. (Age 54) (Claims RCA 11.0 RCM 20.5) 1925 to date Cons. Engr., and1925 to 1935 Valuation Engr., United Railways & Elec. Co. (later The Baltimore Transit Co.); 1935 to 1936 Vice-Pres., and (since 1936) Pres., The Baltimore Transit Co.

HOBART, THOMAS FITZHUGH (Assoc. M.), Birmingham, Ala. (Age 35) (Claims RCA 6.9 RCM 6.7) Aug. 1932 to March 1937 Draftsman Transitman, Acting Chf. of Party and Res. Engr. on location, and April 1938 to date Res. Engr., Alabama Highway Dept., Montgomery, Ala.; in the interim Supt. for Carlton Contr. Co., Albany, Ga.

HORWITZ, SOLOMON (Assoc. M.), Belmont, Mass. (Age 35) (Claims RCA 6.6 RCM 6.0) March 1931 to date Chf. Engr., West End Iron Works, Cambridge, Mass.

HUMMEL, RUSSELL SUTCLIFFE (Assoc. M.), Richmond, Va. (Age 49) (Claims RCA 8.0 RCM 16.4) June 1935 to date with Virginia WPA as Asst. State Administrator, and (since Aug. 1940) State Administrator in charge of entire program.

KELLER, ALLEN WILLIAM, New York City. (Age 44) (Claims RCA 10.8 RCM 9.9) Jan. 1942 to date Asst. Area Planning Engr., FWA, PWR; April 1938 to Jan. 1942 Chf. of Planning and Asst. Archt. Engr., Liaison Agent, FWA, WPA for New York City; previously Cons. Engr. and City Planner; Engr., PWA, Washington, D.C.

KELLY, HENRY JERVEY (Assoc. M.), Chattanooga, Tenn. (Age 36) (Claims RCA 4.1 RCM 6.5) Feb. 1934 to date with TVA as Asst. Civ. Engr., Eng. Service Div., Knoxville, and (since Sept. 1936) Associate Civ. Engr. to Senior Civ. Engr., Maps and Surveys Div., Chattanooga.

KNOWLTON, EZRA CLARK, Holladay, Utah. (Age 51) (Claims RCA 5.4 RCM 18.6) Jan. 1942 to date Executive Vice-Pres. Utah Sand and Gravel Products Corporation; previously Office Engr. in charge of complete engineering office of Constr. Q.M., Ogden and vicinity; with Utah State Road Comm., as Field Engr., Res. or Project Engr., Asst. Chf. Engr., Chf. Engr. and Executive Officer.

LINCOLN, FRANK LOUIS, Arlington Heights, Mass. (Age 38) (Claims RCA 3.5 RCM 10.2) March 1941 to date Engr. with Frederic R. Harris, Inc., Moran, Proctor, Freeman & Mueser, Parsons, Klapp, Brinckerhoff & Douglas, and Fay, Spofford & Thorndike, New York City; previously Designer, Res. Engr., Asst. Engr., and Engr. Fay, Spofford & Thorndike.

MCCLINTOCK, HALLETT EDWARD, Kansas City, Mo. (Age 59) (Claims RCA 26.5 RCM 5.3) March 1929 to date Valuation Engr., U.S. Dept. of Agriculture.

MELCHOR, ALEJANDRO, Fort Belvoir, Va. (Age 41) (Claims RCA 7.6 RCM 6.4) Oct. 1941 to date Major, U.S.A.F.F.E., on duty at Engr. Board, Fort Belvoir; July to Sept. 1941 Official Observer, U.S. Military Academy, West Point, N.Y.; previously graduate student; Prof. and Head of Dept. of Eng., and Acting Head of Dept. of Mathematics, Philippine Military Academy.

MORELAND, JOHN WYLIE, St. Paul, Minn. (Age 44) (Claims RCA 2.3 RCM 12.7) Jan. 1921 to date with U.S. Army, as Lt., and at present Lt. Col., Corps of Engrs., since Nov. 1939 being Dist. Engr., U.S. Engr. Office.

MOSS, ROBERT FAULKNER, Elizabeth, N.J. (Age 60) (Claims RCA 2.4 RCM 31.6) Aug. 1941 to date Vice-Pres., Scientific Concrete Service Corporation, Washington, D.C.; April 1920 to Aug. 1941 Managing-Director, Oriental Steel Products Co., Tokyo, Japan.

NICHOLSON, JOHN BILLINGTON, New York City. (Age 51) (Claims RCA 5.0 RCM 22.0) 1920 to date with The Nicholson Co., Inc., New York City as Vice-Pres., and (since 1926) Pres.

NICKEY, HENRY EUGENE, Arlington, Va. (Age 35) (Claims RCA 2.7 RCM 7.7) Sept. 1941 to date Civ. Engr., U.S. Engrs.; May to Sept. 1941 Civ. Engr., Advance Planning Sec., War Dept., Washington, D.C.; previously Senior Engr. with Chf. Engr., WPA, Harrisburg, Pa.

NORWOOD, FREDERICK JAMES, Cranston, R.I. (Age 41) (Claims RCA 8.5 RCM 9.1) Aug. 1940 to date Structural Engr., Providence (R.I.) Housing Authority; July 1938 to Aug. 1940 with Eng. Dept., Providence, R.I., previously Vice-Pres., G. Fred Swanson, Inc.

PHILLIPS, EDWIN WILLIAM (Assoc. M.), Wilmington, Del. (Age 41) (Claims RCA 3.5 RCM 15.0) Aug. 1920 to date with Levy Court, New Castle County, Wilmington, Del., as Rodman, Draftsman, Instrumentman Inspector, Chf. of Survey Party, Engr., and (since 1937) Prin. Asst. County Engr.

POOLE, BLUCHER ADAMS (Assoc. M.), Indianapolis, Ind. (Age 36) (Claims RCA 1.8 RCM 8.9) June 1931 to date with Bureau of San. Eng., Indiana State Board of Public Health as Asst. Engr., Senior Asst. Engr., and (since Jan. 1935) Chf. Engr.

RANSON, RICHARD ROSE, Diablo Heights, C. Z. (Age 39) (Claims RCA 11.0 RCM 5.0) At present Senior Engr., U.S. Engrs., Panama Canal, Canal Zone; June 1924 to Feb. 1942 with Cutler-Hammer, Inc., Milwaukee, Wis., successively in Development and Eng. Depts.

ROBEY, WALTER EARL (Assoc. M.), Chicago, Ill. (Age 38) (Claims RCA 2.1 RCM 7.0) April 1929 to date with Atchison, Topeka & Santa Fe. Ry. Co., 12$^{3}/_{10}$ years as Bridge Designer, and (since July 1941) Asst. Engr.

RUTLEDGE, JAMES NORMAN, Little Rock, Ark. (Age 41) (Claims RCA 3.1 RCM 13.2) Sept. 1941 to date Planning Engr., Public Work Reserve, FWA; previously with WPA as Dist. Engr., Dist. Director of Operation, Area Supervisor, Area Engr., and Project Engr.

SERBER, GILBERT MORTIMER (Assoc. M.), New York City. (Age 39) (Claims RCA 9.3 RCM 7.9) Oct. 1935 to date Pres. and Gen. Mgr., Stock Constr. Corporation.

STITES, HOWARD INGHAM (Assoc. M.), Burbank, Calif. (Age 41) (Claims RCA 3.7 RCM 12.7) July 1929 to date City Engr.

STOCK, LEO FRANCIS, JR., Washington, D.C. (Age 38) (Claims RCA 10.0 RCM 6.8) Sept. 1935 to date with FSA, Washington, D.C., as Associate Civ. Engr., Chf. Engr.'s Field Representative, Chf., Arch. and Eng. Sec., Region IV, Dist. Engr., Dists. I and II, and (since Dec. 1939) Asst. Chf. Engr.

THOMAS, RODERIC BRUCE (Assoc. M.), Highland Park, Tex. (Age 40) (Claims RCA 2.5 RCM 15.2) June 1928 to date City Engr., Town of Highland Park, Tex.

WATERBURY, LAWRENCE STUART (Assoc. M.), New York City. (Age 45) (Claims RCA 6.4 RCM 16.3) Jan. 1937 to date Associate Engr., Parsons, Klapp, Brinckerhoff & Douglas.

WATFORD, TROY ELLIS (Assoc. M.), Gadsden, Ala. (Age 39) (Claims RCA 9.0 RCM 11.0) 1925 to date with City of Gadsden, Ala., as Asst. City Engr., and (since 1931) City Engr. and Supt. of Water-Works.

WHITNEY, WILLIAM RESTON, Atlantic Highlands, N.J. (Age 48) (Claims RCA 6.3 RCM 13.7) Nov. 1940 to date Chf. Engr., Office of Area Engr., Corps of Engrs., U.S. Army; previously Supt., Carleton Co., New York City; Engr., Beaver Eng. Co., New York City.

APPLYING FOR ASSOCIATE MEMBER

ACKEN, HOWARD WESNER (Junior), New Brunswick, N.J. (Age 32) (Claims RCA 3.8) Oct. 1941 to date Special Asst., New Jersey Dept. of Conservation and Development, Trenton; previously with U.S. Forest Service-CCC, U.S. Dept. of Agriculture as Jun. Foreman, Foreman, Jun. Engr., and Supt. of CCC Camp.

BAUERNSCHMIDT, JOHN GEORGE, Catonsville, Md. (Age 49) (Claims RCA 12.0) 1929 to date with H. H. Robertson Co., as Sales Engr., and (since 1934) Dist. Mgr. in charge of sales in Maryland and Virginia.

BERRY, RALPH MOORE, Kensington, Md. (Age 32) (Claims RCA 5.1 RCM 1.0) Dec. 1934 to Aug. 1935, Dec. 1935 to June 1936 and June 1941 to date with U.S. Coast & Geodetic Survey, reviewing planimetric maps, and (since June 1941) Jun. Cartographic Engr.; in the interim with RA, Continental Life Insurance Co., Suburban Office for Surveyor for Montgomery County, Md., and Maryland National Capital Park and Planning Comm.

BONNER, WILLIAM MITCHELL, JR., Oklahoma City, Okla. (Age 28) (Claims RCA 4.3) Oct. 1941 to date Asst. Engr., W. R. Holway & Associates; May to Oct. 1941 Asst. Engr., Holway & Cochrane, Archt.-Engrs.; previously with Holway & Neuffer, Cons. Engrs. for Grand River Dam Authority, as Asst. Engr., Engr.-Inspector, Special Asst. to W. R. Holway, and Prin. Asst. Constr. Engr.

BROCK, BENJAMIN FRANKLIN, JR., Columbus, Miss. (Age 35) (Claims RCA 9.6) Sept. 1941 to date Chf. Engr., Chandler Bros. Inc.; June to Sept. 1941 Dist. Planning Engr., Mississippi Board of Health; previously Asst. Gen. Supt., Statewide Malaria Control Projects, Defense Areas, WPA; Asst. Project Engr., Mississippi Highway Dept.

BROWN, ROBERT ELY, Toledo, Ohio. (Age 40) (Claims RCA 6.7 RCM 1.5) Aug. 1940 to date Structural Engr., A. Bentley & Sons Co., Gen. Contrs.; May 1935 to Aug. 1940 Asst. Highway Engr., Illinois Highway Dept., Springfield, Ill.

CAWELTI, GEORGE EDWARD, Muscatine, Iowa. (Age 36) (Claims RCA 3.3) Oct. 1935 to Dec. 1937 and March 1938 to July 1939 Res. Engr. with Young & Stanley, Inc., and July 1939 to Nov. 1941 Asst. Engr., with Stanley Eng. Co., Cons. Engrs., Muscatine, Iowa; in the interim Project Engr. for Eastern Iowa Light & Power Cooperative, Davenport, Iowa.

COOK, JOHN HENRY, Fort Worth, Tex. (Age 27) (Claims RCA 7.7 RCM 3.5) Jan. 1933 to date with Tarrant County, Tex., as Constr. Engr., and (since Sept. 1938) County Engr.

CORNELIUS, WILLIAM PASCAL (Junior), Des Moines, Iowa. (Age 31) (Claims RCA 4.2) Dec. 1940 to date 1st Lt., Q.M.C., U.S. Army; previously with Texas Highway Dept., as Plant Inspector, Office Engr., Field Engr., and Jun. Res. Engr., etc.

CRAYNE, LAURENCE EDMUND, Los Angeles, Calif. (Age 37) (Claims RCA 2.0) 1929 to date (except about 10 months student) with California Div. of Highways as Jun. Aide, Senior Field Aide, and (since 1941) Jun. Bridge Engr.

CULLINAN, ROY BERNARD (Junior), Auburn, Mass. (Age 32) (Claims RCA 7.1 RCM 4.1) Dec. 1930 to date Civ. Engr., Massachusetts Dept. of Public Works, Boston Eng. Dept.

D'ALBA, LOUIS, Charleston, S.C. (Age 30) (Claims RCA 2.0) Aug. 1936 to date with U.S. Engr. Office as Sub-surveyman, Surveyman, Student Engr., Jun. Engr. (Civil), and (since Jan. 1942) Asst. Engr. (Civil).

DALPHOND, ARTHUR (Junior), East Orange, N.J. (Age 32) (Claims RCA 9.3) Feb. 1935 to date Production Engr., Federal Shipbuilding and Dry Dock Co., Kearny, N.J.

DEAN, WILLIAM ENNELS, JR. (Junior), Tallahassee, Fla. (Age 32) (Claims RCA 5.7 RCM 2.2) June 1932 to date with Florida State Road Dept., as Instrumentman, Inspector, Asst. Project Engr., Project Engr., Gen. Field Engr., and (since Dec. 1939) Asst. State Bridge Engr.

ERICKSON, IVER, Kansas City, Mo. (Age 30) (Claims RCA 8.8 RCM 7.9) Oct. 1936 to Dec. 1937 and June 1940 to date Design Engr., Standard Oil Co. of Indiana, Sugar Creek Refinery; in the interim with Kansas City (Mo.) School Dist., as Res. Engr., Structural Engr. and Chf. of Field Supervisory force, and Structural Engr., Horner and Wyatt, Cons. Engrs.

ESTRIN, FRED (Junior), Kansas City, Mo. (Age 32) (Claims RCA 8.8) Feb. 1941 to date Chf. Engr., and Supervisor of Constr., Morris Hoffman Constr. Co.; previously with E. T. Archer & Co., Cons. Engrs., Kansas City, Mo., as Draftsman, Fieldman, Designer, Office Engr., Field Inspector, Supervisor, and Office Mgr.

FITZGERALD, JAMES AUGUSTINE (Junior), Miami, Fla. (Age 30) (Claims RCA 4.9 RCM 1.5) Dec. 1940 to date Lt. (jg), CEC, U.S. Navy; previously Chf. of Party, Wilbur Watson and Associates, Cleveland, Ohio; Field Engr., Pittsburgh Plate Glass Co., Columbia Chemical Works, Barberton, Ohio; Civ. Engr., Bates & Rogers Constr. Corporation, Chicago, Ill.; Civ. Engr. and Surveyor in private practice at Ravenna, Ohio.

GADBERRY, JAMES WILLIS, Louisiana, Mo. (Age 30) (Claims RC 6.2 D 6.2) Dec. 1940 to date Office Engr., Bechtel-McCone-Parsons Corporation; March to Dec. 1940 Bldg. and Constr. Engr., The Austin Co., Cleveland, Ohio; previously Asst. Engr. and Party Chf., United Gas System.

GOLDBERG, JOHN EDWARD (Junior), Chicago, Ill. (Age 32) (Claims RCA 5.6 RCM 5.5) Feb. 1933 to date with City of Chicago, 3$^{3}/_{4}$ years with Dept. of Public Works as Asst. to Dist. Engr., Central Dist., Water Pipe Extension Div., and (since Sept. 1936) with Dept. of Bldgs. as Inspector of Bldgs., Central Dist.

GOLDSMITH, MORRIS KING, Los Angeles, Calif. (Age 39) (Claims RCA 8.2) April 1941 to date Structural Engr., Taylor & Taylor, Los Angeles; previously Engr., Lockheed Aircraft Corporation, Burbank; Project Engr., F. J. Twaits Co., and Structural Engr., John C. Austin, Archt., both of Los Angeles; Associate Structural Engr., California State Div. of Architecture.

HEILMANN, JOHN SHERMAN, San Francisco, Calif. (Age 42) (Claims RCA 16.8) June 1941 to date with Army Port Contrs., Port of Oakland, Calif.; previously with MacDonald & Kahn, Gen. Contrs.; Contr. (private practice); with FWA; with Peter J. McHugh, Contr.

HENNINGS, JOHN PORTER, Sharon, Pa. (Age 28) (Claims RCA 5.2) June 1938 to date Res. Engr., Shenango Valley Water Co.; previously Asst. Engr., Springfield City Water Co.

HOAD, JOHN GREEN (Junior), Detroit, Mich. (Age 32) (Claims RCA 4.1) Aug. 1937 to date Engr., The Detroit (Mich.) Edison Co.; previously with Michigan State Highway Dept., as Asst. Civ. Engr., Chf. Clerk, and Equipment Engr.

HOFELDT, HENRY, JR., Rosedale, N.Y. (Age 30) (Claims RCA 3.7) July 1938 to Oct. 1940 Designer and May 1941 to date Designer and Chf. Draftsman with Weiskopf & Pickworth, New York City; in the interim Engr., Hegeman-Harris; previously Structural Steel Draftsman and Designer, Post & McCord.

HOGLIN, HAROLD ALVIN (Junior), Arlington, Va. (Age 32) (Claims RCA 1.5) May 1941 to date Ensign, CEC (V), U.S.N.R., Bureau of Yards and Docks, Navy Dept., Washington, D.C.; previously Jun. Engr., U.S. Bureau of Reclamation, Denver, Colo.

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